DISTRIBUTION, HABITAT, AND SOCIAL ORGANIZATION OF THE FLORIDA SCRUB JAY, WITH A DISCUSSION OF THE EVOLUTION OF COOPERATIVE BREEDING IN NEW WORLD JAYS

BY

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A DISSERTATION PRESENTED TO THE GRADUATE COUNCIL
OF THE UNIVERSITY OF FLORIDA IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1984

To my wife,
Cristy Ann

ACKNOWLEDGEMENTS

I thank the following people who provided information on the distribution of Florida Scrub Jays or other forms of assistance: K. Alvarez, M. Allen, P. C. Anderson, T. H. Below, C. W. Biggs, B. B. Black, M. C. Bowman, R. J. Brady, D. R. Breininger, G. Bretz, D. Brigham, P. Brodkorb, J. Brooks, M. Brothers, R. Brown, M. R. Browning, S. Burr, B. S. Burton, P. Carrington, K. Carstens, S. L. Cawley, Mrs. T. S. Christensen, E. S. Clark, J. L. Clutts, A. Conner, W. Courser, J. Cox, R. Crawford, H. Cruickshank, E. Cutlip, J. Cutlip, R. Delotelle, M. DeRonde, C. Dickard, W. and H. Dowling, T. Engstrom, S. B. Fickett, J. W. Fitzpatrick, K. Forrest, D. Freeman, D. D. Fulghum, K. L. Garrett, C. Geanangel, W. George, T. Gilbert, D. Goodwin, J. Greene, S. A. Grimes, W. Hale, F. Hames, J. Hanvey, F. W. Harden, J. W. Hardy, G. B. Hemingway, Jr., O. Hewitt, B. Humphreys, A. D. Jacobberger, A. F. Johnson, J. B. Johnson, H. W. Kale II, L. Kiff, J. N. Layne, R. Lee, R. Loftin, F. E. Lohrer, J. Loughlin, the late C. R. Mason, J. McKinley, J. R. Miller, R. R. Miller, B. L. Mink, K. Morgan, K. Morrison, M. Mullis, R. Mumme, J. Naylor, D. Nelson, S. A. Nesbitt, H. J. Nett, D. M. Niles, O. Owre, R. Payne, J. K. Pearlman, C. H. Plockelman, M. Plymire, J. and H. Quincy, G. Rawcliffe, C. F. and J. T. Reinholtz, J. V. Remsen, R. W. Repenning, H. Rivers, R. E. Roberts, L. R. Salata, J. F. Sandella, J. Schonewald, J. Sharpe, M. Simons, L. F. Snyder, S. D.

Stedman, H. M. Stevenson, J. Stevenson, Mrs. E. H. Stickney, I. J. Stout, P. W. Sykes, J. G. Taylor, Jr., W. K. Taylor, C. Thorndike, M. B. Trautman, D. K. Voigts, L. H. Walkinshaw, T. Webber, M. Welton, L. E. Williams, Jr., and G. E. Woolfenden. Special thanks go to J. N. Layne for permitting to me work at Archbold Biological Station, and to the staffs of the Lake George and Seminole Ranger Districts (listed individually above), Ocala National Forest, for permission to work in the Forest and other assistance. J. W. Hardy, H. W. Kale II, T. Webber, K. Winnett-Murray, and the members of my committee--M. L. Crump, C. A. Lanciani, J. E. Lloyd, and B. K. McNab--read and commented on various forms of this manuscript. I extend my deepest appreciation to J. W. Hardy and to my wife, Cristy Ann Cox, for their continued support and encouragement. Funds for this research were provided by the Florida Game and Fresh Water Fish Commission, the Frank M. Chapman Memorial Fund of the American Museum of Natural History, and the Florida Ornithological Society.

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Abstract of Dissertation Presented to the Graduate Council of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

DISTRIBUTION, HABITAT, AND SOCIAL ORGANIZATION OF THE FLORIDA SCRUB JAY, WITH A DISCUSSION OF THE EVOLUTION OF COOPERATIVE BREEDING IN NEW WORLD JAYS

by

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August, 1984

Chairman: John William Hardy
Major Department: Zoology

Florida Scrub Jays (FSJs) have declined significantly in numbers because of habitat destruction. FSJs have disappeared entirely from six counties in Florida, and their numbers have decreased substantially in seven additional counties. I estimated the total population size in 1982 to be 15,330-22,530 birds, of which 13,100-20,310 were on protected sites. FSJ numbers will continue to decline as the commercial development of Florida proceeds, but the total population size should stabilize at about 12,780-19,780 birds in a few decades.

The greatest densities of FSJs are in areas with oak thickets 1-3 m tall covering 50-75% of the ground, 10-50% bare ground, and scattered small trees. Some FSJ populations, however, are found in areas with very few oaks, demonstrating their ability to survive in marginal habitats. Fire is effective, and sometimes essential, in maintaining

the habitat in a suitable condition. Mechanical clearing of vegetation, including clear-cutting in Ocala National Forest (ONF), can be an effective substitute for fire.

Scrub Jays in ONF inhabit stands of sand pine scrub clearcut from 1965-1978. Clearcuts can support FSJs only from about 3-5 to 12-15 years after clearing. By the time a young male FSJ is old enough to claim part of his parents' territory, the habitat may no longer be suitable. Because of the continual creation of new habitat, FSJs in ONF are found in smaller groups than those at Archbold Biological Station, Florida.

Blue Jays in Florida typically breed as pairs, but one nest was found that was attended by two males and one female. Behavior of the adults at this nest suggests that this incident was unusual. Florida Blue Jays do not defend territories, but have broadly overlapping home ranges.

The evolution of cooperative breeding in New World jays is discussed. Some of the observed forms of cooperative breeding may not be adaptive, but represent either responses to life in heavily disturbed habitats or the expression of normal parental behavior before a bird becomes a breeder.

CHAPTER 1
GENERAL INTRODUCTION

Florida is something of a mecca for birdwatchers. Many species of birds are found in Florida that are found nowhere else in eastern North America. Among these is the Florida Scrub Jay (Aphelocoma coerulescens coerulescens), a disjunct, relict race of a species that is widespread in the western United States and Mexico.

Florida Scrub Jays are restricted to a distinctive, oak-dominated shrubby habitat known as the scrub. The scrub itself has little commercial value, but it occurs in situations that bestow tremendous value upon it. On the Atlantic and Gulf coasts of Florida, much scrub has been cleared to make way for various types of housing developments: motels, hotels, condominiums, and apartment complexes. Some scrubs farther inland have been cleared for housing developments, and many more have been cleared and replaced with citrus groves. As a result of widespread habitat destruction, the number of Florida Scrub Jays has decreased considerably (Woolfenden 1978a).

Florida Scrub Jays are cooperative breeders. In most species of birds, the young of the year leave their parents as soon as they can feed themselves. Young Florida Scrub Jays do not soon leave their parents, but remain with them for 2-5 years and assist in raising their younger siblings (Woolfenden 1973, 1975, 1981).

This dissertation consists of several parts, following a certain logical sequence. The greatest number of pages (Chapter 2 and Appendix)

is devoted to an investigation of the extent to which Florida Scrub Jay populations have declined and their prospects for future survival. I also investigated the relation between habitat structure and Scrub Jay population density so that I could make valid recommendations for managing Florida Scrub Jay populations (Chapter 3). During the course of that field work, I discovered that Scrub Jays in Ocala National Forest (ONF) do not occupy stable habitat as they do farther south in Florida where their social structure has been closely studied. At ONF, Scrub Jays inhabit areas that were cleared of sand pines roughly 4-15 years ago. Such habitat is transient, forcing Scrub Jays to move from place to place as the habitat changes. The effects of this transient habitat on Scrub Jay behavior are discussed in Chapter 4.

Cooperative breeding by New World jays has attracted considerable attention in recent years. Besides the Scrub Jay, one other species of jay is found in Florida--the Blue Jay (Cyanocitta cristata). As an outgrowth of my interest in Scrub Jays, I undertook a limited study of Blue Jay behavioral ecology, to determine the breeding system of Blue Jays at Gainesville, Florida (Chapter 5).

Finally, I have reviewed certain aspects of habitat use and demography in New World jays in an effort to understand the evolution of social behavior in these birds (Chapter 6). This chapter pulls together information from the preceding parts of this dissertation along with information obtained from the literature on other jay species.

CHAPTER 2
STATUS AND DISTRIBUTION OF THE FLORIDA SCRUB JAY

The Florida Scrub Jay (Aphelocoma coerulescens coerulescens) is aptly named, as it has only once been positively recorded outside of Florida (on Jekyll Island, Georgia; Moore 1975) and is only occasionally seen away from the Florida scrub habitat (Sprunt 1946; Westcott 1970; Woolfenden 1973; pers. obs.). Sprunt (1946) wrote that the Scrub Jay "is so partial to the vegetation it inhabits that it is utterly useless to look for it anywhere else" (p. 78). The Florida Scrub Jay is the only bird that is restricted to the Florida scrub.

Florida Scrub Jays have probably been decreasing in numbers since Europeans first settled Florida, but the decline was first noted by Byrd (1927) and Grimes (1940). Since then, several authors have commented on the decline (Grimes 1943; Early 1952; Longstreet 1954; Sprunt 1954, 1958; Brigham 1973; Austin 1976; Woolfenden 1978a; Cruickshank 1980). The Florida Scrub Jay is listed as "Threatened" by both the Florida Committee on Rare and Endangered Plants and Animals (Kale 1978a) and the Florida Game and Fresh Water Fish Commission (FGFWFC 1981), but the extent of the decline has been unknown.

This study was undertaken to determine the past and present distributions of the Florida Scrub Jay and prospects for its continued existence.

In general, Scrub Jay habitat consists of dense thickets of oaks less than 3 m in height, interspersed with bare sand where the jays cache acorns and forage for other food items (Westcott 1970; Woolfenden 1973; pers. obs.).

The scrub habitat occurs only on fine, white, well drained sands. This type of sand occurs along present coastlines in Florida and in dunes deposited during the past when sea levels were much higher than at present (Laessle 1958, 1968). The most important ancient dune systems are found near the 30-foot, 100-foot, and 150-foot contour levels and include the Atlantic coastal ridge along the Atlantic coast of Florida, the Lake Wales Ridge in Polk and Highlands Counties, and the extensive sand dunes of Ocala National Forest.

Scrub occurs as a variety of plants associations, and a variety of names has been used by different authors to describe the different associations. The type of scrub most commonly occupied by Scrub Jays I call oak scrub. It consists of a single layer of evergreen shrubs, usually dominated by three species of oaks—myrtle oak (Quercus myrtifolia), sand live oak (Q. geminata), and Chapman oak (Q. chapmanii). I refer to these three species collectively as scrub oaks. Other species common in oak scrub include crookedwood (Lyonia ferruginea), silkbay (Persea humilis), rosemary (Ceratiola ericoides), scrub palmetto (Sabal etonia), saw palmetto (Serenoa repens), and Garberia fruticosa (no common name). Trees and herbaceous vegetation are lacking in oak scrub, which was referred to as "scrubby flatwoods" by Laessle (1942) and Woolfenden (1969, 1970, 1973). Sand pine scrub and slash pine scrub have shrub layers like that of oak scrub, plus canopies of trees, either sand pine (Pinus clausa) or slash pine

(P. elliottii). Open sand pine or slash pine scrub has less than 50% canopy cover by trees over 3 m tall. Scrub Jays are rarely found as residents in habitats with more than about 50% canopy cover. Turkey oak scrub, palmetto scrub, and rosemary scrub are oak scrubs with large numbers of turkey oaks (Q. laevis), palmettoes, and rosemary bushes, respectively.

I. J. Stout (MS) mapped the terrestrial plant communities of Merritt Island National Wildlife Refuge and Cape Canaveral Air Force Station and classified Scrub Jay habitats as "flatwoods," "coastal scrub," and "coastal strand." "Flatwoods" have most of the same plant species as oak scrub, but herbs are frequent and slash pines may or may not be present. "Coastal scrub" is dense oak scrub dominated by myrtle oak. "Coastal strand" is a narrow band of vegetation found just behind the beachfront dunes; it is similar to coastal scrub but is dominated by saw palmetto.

Austin (1976) provides a good, general overview of the scrub vegetation and its associated animals. More detailed discussions may be found in Harper (1913, 1915, 1921, 1927), Laessle (1942, 1958, 1968), and Veno (1976).

Procedures

The historical distribution of Scrub Jays in Florida was assessed in several ways, listed below:

1) An extensive literature search was made, including a survey of Christmas Bird Counts published in Bird-Lore (1901-1940), Audubon (1941-1944), Audubon Field Notes (1947-1970), and American Birds

(1971-1983). Since the counts are easily found in these journals, I have not provided references for them in the Literature Cited section.

2) Major ornithological collections in the United States were contacted to determine how many Scrub Jay specimens (study skins, skeletons, and alcohol-preserved specimens) and egg sets were held in each collection, as well as the date and location of collection of each specimen or egg set. Information on 700 specimens and 252 egg sets was obtained from the following collections (the person who provided me with the information on each collection is listed in parentheses after the name of the collection): Academy of Natural Sciences, Philadelphia, Pennsylvania (J. W. Hardy); American Museum of Natural History, New York City, New York (J. W. Hardy); Pierce Brodkorb collection, University of Florida, Gainesville, Florida (J. A. C.); California Academy of Sciences, San Francisco, California (J. Schonewald); Carnegie Museum of Natural History, Pittsburgh, Pennsylvania (J. Loughlin); The Charleston Museum, Charleston, South Carolina (J. K. Pearlman); Central Michigan University, Mt. Pleasant, Michigan (C. W. Biggs); Delaware Museum of Natural History, Greenville, Delaware (D. M. Niles); Field Museum of Natural History, Chicago, Illinois (J. W. Fitzpatrick); Florida State Museum, Gainesville, Florida (J. A. C.); Los Angeles County Museum of Natural History, Los Angeles, California (K. L. Garrett); Louisiana State University Museum of Zoology, Baton Rouge, Louisiana (J. V. Remsen); Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts (C. W. Biggs); Museum of Vertebrate Zoology, University of California, Berkeley, California (A. D. Jacobberger); Ohio State University Museum of Zoology, Columbus, Ohio (M. B. Trautman); Peabody Museum of Natural

History, Yale University, New Haven, Connecticut (E. H. Stickney); Tall Timbers Research Station, Tallahassee, Florida (H. M. Stevenson); United States National Museum of Natural History, Washington, D.C. (M. R. Browning); University of Central Florida, Orlando, Florida (W. K. Taylor); University of Kansas Museum of Natural History, Lawrence, Kansas (J. A. C.); University of Miami Research Collection, Coral Gables, Florida (C. W. Biggs); University of Michigan Museum of Zoology, Ann Arbor, Michigan (D. Nelson); Virginia Polytechnic Institute and State University, Blacksburg, Virginia (T. Webber); Western Foundation of Vertebrate Zoology, Los Angeles, California (L. Kiff); Glen E. Woolfenden collection, University of South Florida, Tampa, Florida (G. E. Woolfenden). The museum survey was not exhaustive; after a certain point, further searching failed to reveal new localities.

3) I obtained the results of Florida Breeding Bird Surveys (BBS) from the U. S. Fish and Wildlife Service. The BBS program in Florida began in 1966. A BBS consists of a 24 and 1/2 mile route with 50 stops placed at one-half mile intervals. Beginning 30 min before sunrise, an observer drives the route, recording birds seen or heard in one 3-min period at each stop. Observers and car odometers vary, so stops are not always made at the same locations each year. Therefore, locations where Scrub Jays have been reported on Breeding Bird Surveys are only approximate.

4) Chandler S. Robbins provided me with copies of the Bureau of the Biological Survey (now U. S. Fish and Wildlife Service) files on Florida Scrub Jays. The files are kept at Patuxent, Maryland. The files were used by Howell (1932) in compiling the species accounts in

Florida Bird Life. Included in them are an extensive set of literature citations, as well as numerous unpublished records of Scrub Jays from the field notes of various Biological Survey biologists and references from conversations and correspondence of the biologists with other people. These reports are referred to in the text as the Biological Survey files (abbreviated Biol Surv. files).

5) A survey was made of members of the Florida Ornithological Society in fall, 1980, to obtain information regarding the present distribution of Florida Scrub Jays. Some members, on their own time and at their own expense, made extensive searches for Scrub Jays in their areas. Other members provided locality information, or information concerning the past distribution of Scrub Jays. All of this information was most helpful.

In 1981, I conducted an extensive field survey of Florida Scrub Jay distribution. I tried to visit all locations at which Scrub Jays were known or suspected to exist, and disccvered several new populations in the process. I also visited areas from which Scrub Jays were known to have been extirpated already and scrub sites from which Scrub Jays had never been reported. This survey forms the primary basis for the county-by-county summaries that follow.

Because of the limited amount of time in which to cover most of the Florida peninsula, most of the survey was conducted along public roads and highways. The usual survey technique involved walking or driving slowly, playing a tape recording of Scrub Jays "screech scolds" (Barbour 1977). The scold notes are given by Scrub Jays when they see snakes, and other snakes typically respond by flying rapidly to the site of the calls and mobbing excitedly. By playing the tape, I could

sometimes attract jays from a distance of 500 feet, greatly facilitating the survey. Without the recordings, the survey would have been inefficient and exceedingly time-consuming. I played the tape whenever I encountered habitat potentially suitable for Scrub Jays. If jays appeared quickly, I counted them and moved to another location. If no jays appeared, but the habitat looked like good Scrub Jay habitat, I played the tape for 10-15 minutes and tried to visit that spot again before concluding that no jays were present in the area.

No doubt I missed Scrub Jays entirely in some places where they are present. I suspect, however, that the number of such places is low. Some Scrub Jays live in inaccessible locations, but few large areas of scrub are entirely inaccessible. I am confident that I missed few large populations, although I may have missed many small ones. Therefore, I have used terms such as "probably," "maybe," and "likely" throughout this paper. It is simply not possible to conduct in one year an absolutely complete survey of a species present in as many widely scattered locations as the Florida Scrub Jay.

I urge ornithologists and birdwatchers in Florida to search for Scrub Jays in places where I failed to find any and where apparently suitable habitat still exists. If Scrub Jays are found in locations not mentioned in this report, please contact the author, or the Curator of Ornithology, Florida State Museum, University of Florida, Gainesville, Florida 32611, USA. Reports are also requested concerning populations that have been extirpated.

County Summaries

The summaries that follow provide detailed analyses of the status of Scrub Jays in each Florida county from which they have been reported. Figure 1 shows locations of counties from which Scrub Jays have been reported. Specific site locations are given in the Appendix. Sites listed in the Appendix are referred to in the text by the county name and a number. The cities and towns under which the sites are listed in the Appendix can be found on the Florida highway map published by the American Automobile Association. I have provided road directions, as well as Township, Range, and Section numbers, for each site, to ensure that they can be relocated in the future by other investigators.

I have also included a paragraph about specimens for which locations are too vague to assign to any one county. There are also reports of Scrub Jays from several localities that I find questionable, and I have included a discussion of those records.

Although metric measurements have become the standard in scientific publications, I have given road distances in miles, for two reasons: 1) most car odometers read in miles; and 2) virtually all maps show distances in miles. Furthermore, the Township, Range, and Section system of land mapping uses the mile as its standard unit of measurement. The use of miles in road directions will facilitate the location of most sites. All other measurements are given in metric units.

Abbreviations used frequently in the county summaries and in the Appendix are as follows: N, S, E, W, NE, SE, SW, NW--compass

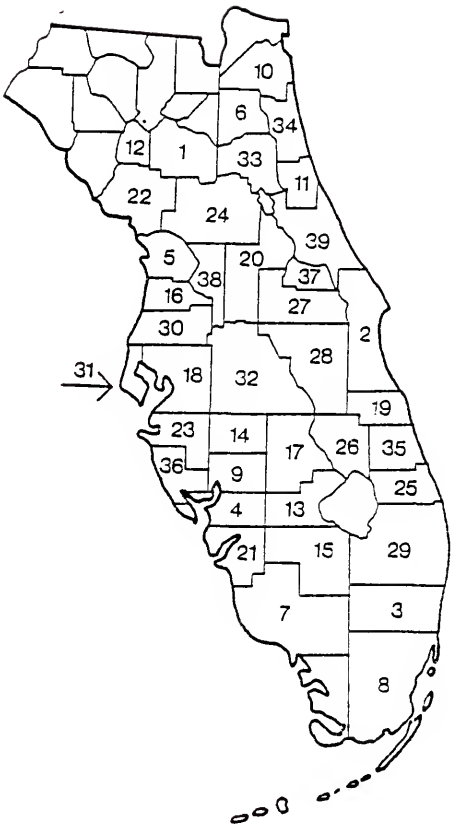

Figure 1. Locations of Florida counties from which Florida Scrub Jays have been reported. 1--Alachua Co.; 2--Brevard Co.; 3--Broward Co.; 4--Charlotte Co.; 5--Citrus Co.; 6--Clay Co.; 7--Collier Co.; 8--Dade Co.; 9--DeSoto Co.; 10--Duval Co.; 11--Flagler Co.; 12--Gilchrist Co.; 13--Glades Co.; 14--Hardee Co.; 15--Hendry Co.; 16--Hernando Co.; 17--Highlands Co.; 18--Hillsborough Co.; 19--Indian River Co.; 20--Lake Co.; 21--Lee Co.; 22--Levy Co.; 23--Manatee Co.; 24--Marion Co.; 25--Martin Co.; 26--Okeechobee Co.; 27--Orange Co.; 28--Osceola Co.; 29--Palm Beach Co.; 30--Pasco Co.; 31--Pinellas Co.; 32--Polk Co.; 33--Putnam Co.; 34--St. Johns Co.; 35--St. Lucie Co.; 36--Sarasota Co.; 37--Seminole Co.; 38--Sumter Co.; 39--Volusia Co.

directions; SR (number)--state highway (route) number; FR (number)--Forest Service road number (Ocala National Forest); US (number)--United States Highway number; SCL RR--Seaboard Coast Line Railway; FEC RR--Florida East Coast Railway; ad--adult-plumaged Scrub Jay (blue head); juv--juvenile Scrub Jay (brown head); in litt.--in a letter. The "center" of a section refers to an area nearly equidistant from all sides; the "middle" of a section refers to a transect across the section in the specified direction.

Unspecified Localities

For 17 Scrub Jay specimens collected from 1872 to 1962, the only location given is "Florida." Specimens from the following locations could be from any of the counties listed after them in parentheses: Indian River, 16 specimens, 1875-1920 (Brevard, Volusia, Indian River, St. Lucie, or Martin); Anclote River, 1 specimen, 1874 (Pasco or Pinellas); upper St. Johns River, 2 specimens, 1887 (Volusia, Lake, Seminole, Brevard, or Orange); Lake Harney, 1 specimen, 1887 (Volusia or Seminole); Big Lake George, 4 specimens, 1885-86 (Marion, Putman, Lake, or Volusia); Withlacoochee River, 1 specimen, 1929 (Citrus, Hernando, Lake, Levy, Marion, Pasco, Polk, or Sumter); and near Shiloh, 5 specimens in 1947, and 2 egg sets in 1967 and 1968 (Brevard or Volusia).

Questionable Localities

There are two egg sets that, according to the labels, were collected in Leon County (no more specific location was given for either set): Field Museum of Natural History, catalog number 1408, 4

eggs, collected by L. Whitfield, no date given; and Peabody Museum of Natural History, no catalog number, 4 eggs, collected 21 May 1894 by R. W. Williams, Jr. J. W. Fitzpatrick (in litt.) has examined the egg set at the Field Museum, and states that the eggs "are those of Florida Scrub Jay," but H. M. Stevenson (in litt.) feels that the eggs may be Blue Jay eggs. Mrs. E. H. Stickney (in litt.) has examined the eggs at the Peabody Museum, and feels that they are those of a Blue Jay. R. W. Williams, the collector of the Peabody set, later published several papers on the birds of Leon Co. (Williams 1904, 1906, 1907, 1914, 1928, 1929). In none of those papers did he mention Scrub Jays; he obviously rejected as false his own Leon Co. Scrub Jay record.

Bartsch (1917) reported the "Florida Jay" from Rockdale, Dade Co., on 24 June 1916. There were some patches of scrub, or at least oak thickets, as far south as Florida City (D. F. Austin, in litt.). No one else has reported Scrub Jays from that far south, however, so Bartsch's record deserves further scrutiny. Bartsch had made 3 previous trips to south Florida, and on each trip he kept a list of birds observed (Bartsch 1914, 1915, 1916). In the reports on trips after the first one, he made separate lists of species not observed on previous trips. The "Florida Jay" was not listed among the new birds seen in 1916, nor had it been reported from any of the previous trips. Furthermore, Bartsch (1917) reported a "total list of 54 species" (p. 182). On pp. 187-188, he listed the scientific names of all birds seen; that list totals 54 species, but does not include Aphelocoma coerulescens, or any of its synonyms. The "Florida Blue Jay" is not among the birds Bartsch (1917) reported from Rockdale in 1916. It is

possible that Bartsch did see a Scrub Jay at Rockdale, but it is just as likely that the report of a "Florida Jay" from Rockdale in 1916 is in error--the result of the accidental deletion of one word--and that the bird actually seen was a Florida Blue Jay.

Crichlow (1928) reported Scrub Jays from several locations not mentioned by anyone else: "Nassau County (near Fernandina on the beach), . . . Volusia County (Ortona . . .), . . . Dade County (. . . Cocoanut [sic] Grove), Citrus County (. . . Lecanto)" (p. 51). Crichlow further stated that Scrub Jays were nowhere found more than 3 miles inland (even though LeCanto is ten miles inland). There is a town of Ortona in Glades Co., and Scrub Jays live near there; I have been unable to locate an Ortona in Volusia Co. Fernandina Beach is 15 miles farther north than the northernmost location reported by anybody else (the mouth of the St. Johns River). If Rockdale is rejected as a former location for Scrub Jays, Coconut Grove is about 7 miles farther south than the next most southern location--Little River. In the same article, Crichlow wrote that he had found Gray Kingbirds nesting in hollow trees and nest boxes--the only record of Gray Kingbirds nesting in cavities, if true (cf. Sprunt 1942). Howell (1932) listed Crichlow's paper in the Bibliography to his Florida Bird Life, but did not list LeCanto, Ortona, Coconut Grove, or Fernandina Beach as Scrub Jay locations in the text. Apparently, because of the many doubtful statements in Crichlow's paper, Howell rejected some or all of Crichlow's data. I have excluded all of Crichlow's locations.

There is one Scrub Jay specimen from Key West, Monroe Co., dated 27 December 1883. There are no other records of Scrub Jays from

anywhere in Monroe County. Key West is 150 miles from North Miami, the closest likely source of wild birds, so it seems likely that the bird was an escaped cage bird, as suggested by Pitelka (1951). Audubon (1840-1844) reported Scrub Jays being kept as cage birds in New Orleans, lending some credence to that idea. H. M. Stevenson (in litt.) has examined the Key West specimen and says it lacks "the worn remiges and rectrices characteristic of most caged birds." However, the bird could have molted after its escape or release, or it may not have spent much time in captivity. I think it unlikely that Scrub Jays were ever resident at Key West.

Bendire (1895) wrote that Scrub Jays did not occur "north of Pine Point . . . on the Gulf Coast" (pp. 370-371). Howell (1932) listed "Pine Point" as a locality for Scrub Jays, and his range map indicates that he was referring to what is now called "Piney Point" in Taylor County. I have examined the Scrub Jay records in the files used by Howell in writing Florida Bird Life. The files include a card for Bendire (1895), mentioning "Pine Point," but there is no other reference in the file to Pine Point or Piney Point. I presume, then, that Bendire (1895) was Howell's only source for "Pine Point." Sprunt (1946) also stated that Scrub Jays were present up to Pine Point, just north of the mouth of the Suwannee River. I presume again that Sprunt was only following Bendire (1895) and Howell (1932) in listing Pine Point.

There is some scrub near Piney Point, Taylor Co., but I know of no definite records of Scrub Jays from Piney Point or anywhere else in Taylor County. There are, in fact, many "Pine Points" and "Piney

Points" scattered all along the west coast of Florida. It is debatable to which Pine Point Bendire (1895) referred. I recommend, therefore, that Taylor County be excluded from the known historical range of Scrub Jays until definite evidence of their existence there comes to light.

Alachua County (Figure 2)

Historical. Baynard (1913) reported that Scrub Jays were very rare within 20 miles of his Micanopy home and that he had only once found them nesting in Alachua Co. Four Scrub Jays were collected 2 miles south of Cross Creek in 1963. The Cross Creek location is within 20 miles of Micanopy and may be the place where Baynard had found Scrub Jays. Howell (1932) reported that Scrub Jays were found at Micanopy, and Sprunt (1946) reported Scrub Jays north to Gainesville. I suspect that both of those writers were referring to Baynard's (1913) paper, and that the exact location in question is, in fact, the Cross Creek site.

Fossil remains of Scrub Jays have been found in late Pleistocene deposits near Arredondo (Brodkorb 1959) and Haile (Ligon 1965). There is at present no scrub within several miles of either of those locations. The fossils indicate that Scrub Jays and, presumably, the scrub itself, were more widespread in north-central Florida several thousand years ago.

Present. I made several visits in 1980 and 1981 to the location 2 miles south of Cross Creek; on none of them did I find Scrub Jays. The small area of scrub there is now quite overgrown and dense, apparently due to the absence of fire, and appears unsuitable for Scrub Jays.

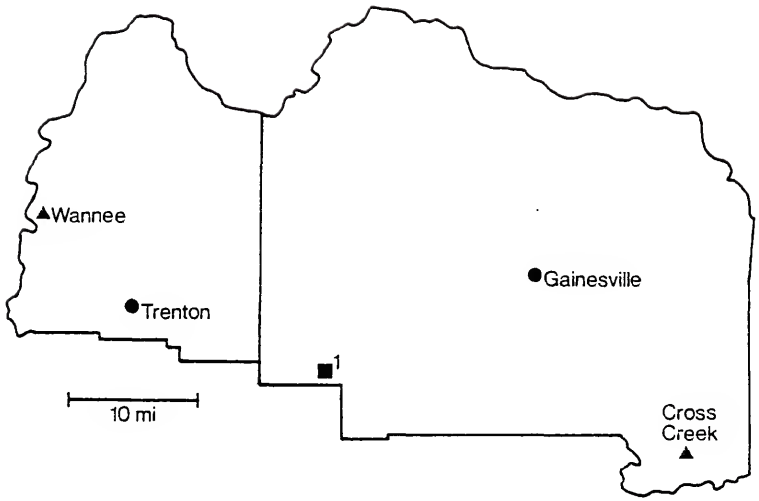

Figure 2. Locations of Scrub Jay records in Alachua (right) and Gilchrist (left) Counties, Florida. Square--location of Scrub Jay population, 1980-1983 (number refers to list of sites in Appendix); triangles--former Scrub Jay populations; circles--other towns and cities.

There is one locality in Alachua Co. where I found Scrub Jays in 1981--on the Levy Co. line, west of Archer (Alachua Co. 1; this site is adjacent to Levy Co. 1). This small tract of atypical turkey oak scrub apparently supported a single family of jays in 1981 and was gradually being cleared by its owner. It is likely that in a few years no Scrub Jays will remain in Alachua Co.

Brevard County (Figure 3)

Historical. Scrub Jays have been reported in the ornithological literature from the following locations in Brevard Co.: Cape Canaveral (Hoxie 1889; Howell 1932); Dummitt's (south of Haulover Canal; Allen 1871); Eau Gallie (Howell 1932); Georgiana (Howell 1932); Indian River City (Sprunt 1946); Melbourne (Brookfield 1949); Merritt Island (Sprunt 1946); Micco (Baker 1889); Titusville (Jackson 1887; Bendire 1895); and Wilson (Howell 1932). Maynard (1881) reported that Scrub Jays were common east of the Indian River, south at least to Merritt Island. Hoxie (1889) stated that Scrub Jays were fairly common within 2-3 miles of Cape Canaveral. H. Schroder (in Sprunt 1946) stated that he had found more Scrub Jays on Merritt Island than anywhere else in the state. Sprunt (1946) suggested that the best place to study them would be in the narrow strip of scrub between the Indian River and the Florida East Coast Railway tracks, especially south of Indian River City. Brookfield (1949) wrote that Scrub Jays were "gratifyingly numerous along the coast" in the Melbourne area.

Christmas Bird Counts conducted in the Titusville-Merritt Island National Wildlife Refuge area since 1934 show a maximum of 253 Scrub

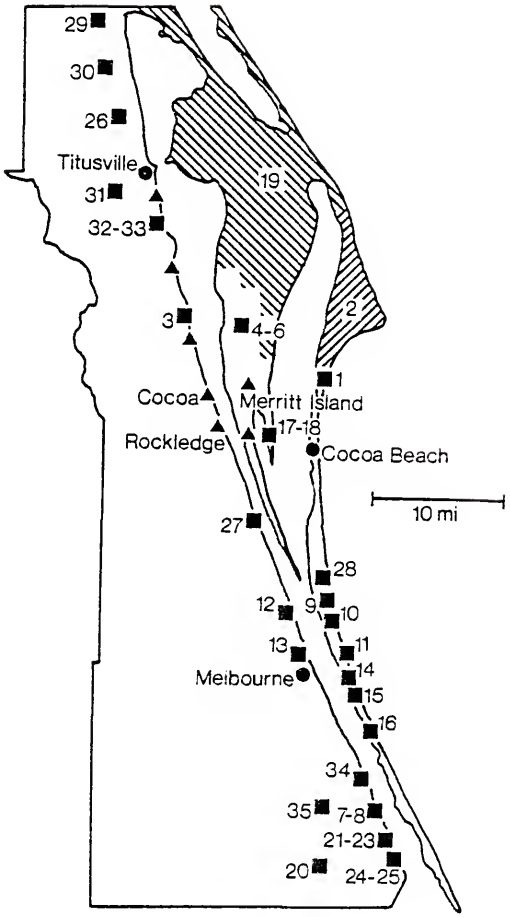

Figure 3. Locations of Scrub Jay records in Brevard County, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations; circles--other towns and cities.

Jays in 1975. Most of those counts, however, have recorded fewer than 100 jays. Christmas counts made at Cocoa from 1951-1982 reached a high of 106 Scrub Jays in 1957, but no more than 33 jays have been counted since 1973. Christmas counts in South Brevard Co. (Micco area, but including parts of Indian River Co.) from 1966-1982 showed highs of 41 Scrub Jays in 1970 and 1973. Some of the birds in each year were seen in Indian River Co. Only 2 jays were seen on the 1982 count.

At least 159 specimens and 134 egg sets of Scrub Jays have been collected in Brevard Co. Information on the skins and skeletons is summarized in Table 1, and egg set data are summarized in Table 2. Totals of 66 specimens and 46 egg sets were collected on the mainland; the remainder were collected on Merritt Island or the barrier islands. It is apparent from the numbers collected that Scrub Jays in the past were fairly common at Eau Gallie, Indialantic, Titusville, and on Merritt Island. Egg sets show a nearly continuous distribution from Titusville to about 5 miles north of Cocoa.

Scrub Jays were reported on the Scottsmoor Breeding Bird Survey in 1969, 1971, 1972, 1973, and 1977, when jays were seen on stops 41, 42, 45, 48, 49, and 50. All of those stops are in Merritt Island National Wildlife Refuge, within 2 1/2 miles of the intersection of SR 402 and Kennedy Parkway North.

There are several Brevard Co. records of Scrub Jays in the Biological Survey files. D. J. Nicholson wrote in 1926 that Scrub Jays were abundant from "Point Canaveral to Cocoa Beach . . . about 75 seen in 2 miles on the beach between Banana River and the ocean." Other locations and dates of Scrub Jay records in the Biological Survey files

Table 1. Locations, dates, and numbers of Scrub Jay specimens (study skins plus skeletons) collected in Brevard Co., Florida.

	1860-1899	1900-1939	1940-1979	no date	Totals
Allenhurst		7			7
Banana Creek		1			1
Banana River	1	6			7
Cape Canaveral	4	1		1	6
Dummitt's	2				2
Eau Gallie	1	23		4	28
Georgiana	7				7
Grant	2	1			3
Indian Harbor Beach			2		2
Indian River City		2			2
Indianola	2				2
near Malabar	1				1
Melbourne	1	2			3
Merritt Island	3	4	27		34
Micco	13		1		14
Titusville		6	9		15
Wilson		9	4		13
unspecified	4	6		2	12
Totals	41	68	43	7	159

Table 2. Locations, dates, and numbers of Scrub Jay egg sets collected in Brevard Co., Florida.

	1870-1909	1910-1949	1950-1979	no date	Total
Allenhurst/ Haulover Canal		1	2		3
Banana Creek			2		2
Banana River	3		1		4
Cocoa, 5 mis N		1	2		3
Cocoa, 4-4.5 mis S		2			2
Cocoa, 6 mis S		1			1
between Cocoa and Indian River City		1			1
Courtenay		2			2
Courtenay, 3 mis N			2		2
Courtenay, 4-4.5 mis N			3		3
Delespine			3		3
Delespine, 1 mi N			2		2
Delespine, 2 mis S		1	1		2
Delespine, 3 mis S		1			1
Delespine, 4 mis S		1	1		2
Eau Gallie		1			1
Haulover Canal, 2 mis S			1		1
Indialantic			13		13
Indian River City, at and near		2	2		4
Indian River City, 1 mi N			1		1
Indian River City, 1 mi W			2		2
Indian River City, 2 mis W		1			1
Indian River City, 3 mis W		1			1
Indian River City, 2 mis S			2		2
Melbourne			1		1
Merritt Island, opposite Titusville			1		1

Table 2, continued.

	1870-1909	1910-1949	1950-1979	no date	Total
Merritt Island, between SR 520 & 528			2		2
Merritt Island, S of SR 520			3		3
Merritt Island, unspecified		4	22		26
Palm Bay (near)		1			1
Titusville	1		11	1	1
Titusville, 2 mis S			3		3
Titusville, 3-4 mis NE		6			6
Titusville, 12 mis E		5			5
Wilson, at and near		6	3		9
Wilson, 2 mis E		1			1
Wilson, 6 mis S		1			1
Wilson, 8 mis S		1			1
unspecified		2			2
Totals	4	43	86	1	134

include Melbourne, 1889 (M. M. Green); Titusville, 1888 (W. Hoxie); 3 miles west of Titusville, 1889 (M. M. Green); and Melbourne Beach, 1917 (F. Harper).

Cruickshank (1980) stated that Scrub Jay numbers in Brevard Co. have declined sharply since 1955 due to habitat destruction, but he added that Scrub Jays remain common in undeveloped portions of the county, especially on Cape Canaveral and Merritt Island.

On the data sheet for a set of Scrub Jay eggs he collected 21 March 1960 in Titusville, D. J. Nicholson wrote that the nest was found in a 5-acre scrub "across the street from a row of occupied houses . . . [t]he last stronghold of this fine jay in Titusville, when once, only a few short years ago, these jays were very abundant in Titusville, but no longer!" He added a brief note that the clearing of scrub for houses "shall mean the end to all our Florida jays."

R. Brown (in Cleveland 1980) suggested that there may have been as many as 20 pairs of Scrub Jays in Melbourne Beach prior to the clearing of land for Spessard Holland Golf Course.

J. B. Johnson, who has lived in Brevard Co. since the 1950's, indicates (in litt.) that Scrub Jays were fairly common around the towns of Cocoa, Cocoa Beach, and Merritt Island in the 1950's. He thinks that the number of jays may have decreased by as much as 90% in those areas, due to development. He has been unable to find any Scrub Jays on Merritt Island west of Sykes Creek and Newfound Harbor, and south of SR 528, for several years.

A tract of scrub that supported a few Scrub Jays on Barnes Blvd, west of US 1 in Rockledge was cleared in 1982 (H. Cruickshank, in litt.).

Present. Merritt Island National Wildlife Refuge (MINWR; Brevard Co. 19), which contains Kennedy Space Center, was censused by L. R. Salata (MS), who estimated that there are between 2600 and 4800 jays on the refuge (Table 3). He censused birds by playback of Scrub Jay alarm calls at several points along each of 17 transects in different habitats with Scrub Jays. He sampled each transect 7 times, and calculated densities using the maximum number of birds seen on each transect on any of the sample dates. Using maxima might overestimate the true density, since it might include some birds from outside the census areas. That problem is at least partly countered, however, by the fact that Salata played the tape for only 2 min at stops 150 m apart. Some birds may have been missed between stops, and 2 min is not always enough time for Scrub Jays to respond to a tape recording (pers. obs.). His maximum population estimate was obtained under the assumption that he counted all birds present within a transect 336 m wide; the minimum estimate used a transect width of 524 m. Although some jays will respond from the edges of transects of that width, I think it is unlikely that all birds within even 168 m would have been attracted to the source of the calls. Salata may have underestimated the number of Scrub Jays at MINWR, possibly severely so.

Breininger (1981) also censused Scrub Jays at MINWR as part of a study to determine the preferred habitats of Scrub Jays there. He used three methods to estimate jay densities; I shall consider only two of those methods here. (Results of the three methods were generally similar.) The first method, the "Alarm Call method", was similar to that used by Salata (MS): Jays were attracted to be counted by

Table 3. Estimates of population densities (birds/40 ha) in different habitats, and total population size, of Florida Scrub Jays at Merritt Island National Wildlife Refuge, Florida. See text for further explanation.

		Salata		Revised Salata[a]		Breininger BAL		Breininger Alarm	
Habitat	Area (ha)	Density(n)[b]	Birds	Density(n)	Birds	Density(n)	Birds	Density(n)	Birds
oak scrub (= "flatwoods")	8451	7.7-14.1(11)[c]	1627-2979	48.0(11)[c]	10,141	40.7 (6)	8599	35.3(6)	7458
coastal scrub	2622	12.6-23.0 (4)	826-1508	70.6 (4)	4628	59.0(12)	3867	66.6(10)	4326
coastal strand	379	7.8-14.4 (2)	74- 134	55.7 (2)	528	66.4 (5)	629	79.0 (4)	749
Total	11,452		2577-4621		15,297		13,095		12,533

[a]using mean transect width of 80 m (area = 7.04 ha) and mean number of birds seen per census per transect.

[b]maximum and minimum estimates.

[c]weighted averages of densities in "pine flatwoods" and "pineless flatwoods" (Salata MS)

playback of tape-recorded Scrub Jay alarm calls. Unlike Salata, however, Breininger felt that he was able to count all jays within a distance of only 40 m. That difference alone would create a fourfold difference in density estimates. Breininger also used the Fourier series method of Burnham et al. (1980) to estimate Scrub Jay densities along most of the same transects and a few additional ones. This method uses the distance from the transect center line at which each bird was sighted to estimate population density in a more objective manner than the Alarm Call method. Using the initials of the three authors of the paper (Burnham, Anderson, and Laake), this method is referred to as the BAL method.

In Table 3, I have presented the densities of Scrub Jays in three different habitats at MINWR, as calculated by Salata (MS), Breininger's (1981) Alarm Call method, and Breininger's BAL method. Salata (MS) also measured the areas covered by each of those habitats from a vegetation map of MINWR (Stout MS). The habitat areas are given in Table 3, and permit one to calculate the total number of Scrub Jays at MINWR. I have also recalculated population densities from Salata's data, using a transect width of 80 m instead of 336 or 524 m, and the mean number of birds seen per census. There is a large discrepancy between Salata's original population estimates and the estimates derived from Breininger's (1981) density estimates, or the revised Salata densities. There are few differences, however, between the two sets of Breininger's figures.

Breininger (1981) had six transects on which he estimated Scrub Jay densities >80 birds/40 ha. These are by far the highest densities

ever reported for Florida Scrub Jays. The highest density Salata (MS) found was about 23.0 birds/40 ha. In several inland sites, the highest density I found was 23.6 birds/40 ha. At Archbold Biological Station, Highlands Co., Florida--the site of an intensive, long-term study of Scrub Jay biology--the density is only about 10 birds/40 ha (Woolfenden and Fitzpatrick MS). Breininger (pers. comm.) has collected further data that corroborate his earlier finding of densities over 80 birds/40 ha. He is not certain, however, about how widespread the very high densities are. His transects were not randomly located in all available habitat, although they did represent a wide range of Scrub Jay habitats. It is likely that the very high densities he found in some areas are restricted to a few local areas (see Chapter 3). The actual average density of Scrub Jays at MINWR is therefore probably somewhat less than the simple average of the densities given by Breininger (1981), but it cannot be determined at this time. As a partial solution to this dilemma, I have taken the means of the highest and lowest densities reported for each habitat. For oak scrub (= flatwoods of Salata and Breininger), the figure is (7.7+48.0)/2 = 27.8 birds/40 ha, for a total of 5873 Scrub Jays. For coastal scrub, the mean is (12.6+70.6)/2 = 41.6 birds/40 ha, or 2727 Scrub Jays. For coastal strand, the mean is (7.8+79.0)/2 = 43.4 birds/40 ha, or 411 Scrub Jays. The grand total is 9011 Scrub Jays. Finally, it is necessary to take into account the amount of habitat that has been cleared for Kennedy Space Center. From aerial photographs taken in 1979, it appears that about 10% of the scrub at MINWR has been cleared. Deducting 10% from 9011, I arrive at a total

population size of about 8100 Scrub Jays. Because of the way it was calculated, that figure must be considered a very rough estimate, and it could be off by 25% (or more) in either direction, so I will use a figure of 6000-10,000 jays at MINWR.

The U.S. Fish and Wildlife Service has begun a program of controlled burning of all scrub at MINWR. Unless it occurs too often, fire helps to maintain the suitability of scrub for Scrub Jays (see Chapter 3). If the entire refuge is not burned more frequently than every 6-9 years, the total number of Scrub Jays should not change much from its 1980 level, although expansion of Kennedy Space Center facilities will cause the destruction of some Scrub Jay habitat.

Cape Canaveral Air Force Station (CCAFS) is covered predominantly by coastal scrub and coastal strand habitats similar to those at MINWR. CCAFS is adjacent to MINWR, and I have assumed that Scrub Jay densities are the same at CCAFS as in the similar habitats at MINWR. Density estimates and habitat areas are shown in Table 4. Densities for the two habitats under each estimation method are the same as those in Table 3. Using a polar planimeter, I measured the habitat areas from a vegetation map of MINWR and CCAFS (Stout MS). Total population estimates range from 1654 to 9522 Scrub Jays, but the problems discussed above, with regard to MINWR, apply here also. Using the means of the high and low density estimates for each habitat, I derive a total of 4914 Scrub Jays in coastal scrub, and 921 jays in coastal strand, for a grand total of 5835 Scrub Jays at CCAFS. The scrub at CCAFS has suffered relatively more clearing than that at MINWR. Again using 1979 aerial photographs, it appears that about 20% of CCAFS has

Table 4. Estimates of total population size of Florida Scrub Jays at Cape Canaveral Air Force Station, Florida. Densities in different habitats are assumed to be the same as at Merritt Island National Wildlife Refuge (see Table 3).

		Salata	Revised Salata	Breininger BAL	Breininger Alarm
Habitat	Area (ha)	Birds	Birds	Birds	Birds
Coastal Scrub	4725	1488-2717	8340	6969	7796
Coastal Strand	849	166- 299	1182	1409	1677
Total	5574	1654-3016	9533	8378	9473

been cleared. Accordingly, the grand total at CCAFS is reduced to 4668 Scrub Jays. That figure, like the one of 8110 birds at MINWR, might be off by 25% in either direction, so I will use a figure of 3600-6000 birds. Habitat clearing for construction in the future will decrease the number of birds somewhat.

Outside of Merritt Island National Wildlife Refuge and Cape Canaveral Air Force Station, the future of Scrub Jays in Brevard Co. appears rather bleak. As shown by the locations of egg sets, Scrub Jays must have been nearly continuously distributed along US 1 from Titusville to about 5 miles north of Cocoa (Table 2). At the present time, Scrub Jays are known from only two places along that stretch of US 1: at the intersection of US 1 and SR 405, about 2 miles south of Indian River City (Brevard Co. 33); and about 6 miles north of Cocoa (Brevard Co. 3). The latter site is about 3 miles south of Delespine, and is undergoing rapid and extensive development. There is very little scrub left between Titusville and Cocoa. [Scrub Jays are also present north of SR 405, about one mile west of US 1 (Brevard Co. 32)--a population possibly continuous with Brevard Co. 33--and about 3 miles west of Titusville (Brevard Co. 31), a site apparently not visited by collectors, although M. M. Green reported Scrub Jays from that general area in 1889 (Biol. Surv. files)].

Scrub Jays were found at a total of 20 mainland locations, but only the Valkaria airport scrub (Brevard Co. 34) seems at all secure. There are probably a few undetected Scrub Jay populations along the Florida East Coast Railway tracks; the railroad populations and a few other mainland populations (e.g., Brevard Co. 7 and 24) may persist indefinitely, but none of those populations is very large.

On Merritt Island and the barrier islands, the prospects for Scrub Jays are even worse than on the mainland. Except for areas in MINWR and CCAFS, almost all of the scrub has been cleared or is being cleared. Thirty-four Scrub Jays were seen on the islands south of SR 528, including 2 on Merritt Island, but only one of those birds was in a site that appears at all safe--at the Girl Scout Center on Horti Point (Brevard Co. 17). No more than 10 adult Scrub Jays were found at Melbourne Beach, perhaps only a quarter of the former population. An additional 4 birds were seen near Courtenay. Development is rampant on the barrier island and around the town of Merritt Island. I expect Scrub Jays to be almost completely gone from those areas in 5 to 10 years.

Nevertheless, with the presence of Merritt Island National Wildlife Refuge and Cape Canaveral Air Force Station, the continued existence of 9600-16,000 Scrub Jays in Brevard Co. seems assured.

Broward County (Figure 4)

Historical. There are 2 Scrub Jay specimens from Broward Co.: one from Hallandale in 1962, and one from Fort Lauderdale in 1970. One egg set was collected at Hollywood in 1923. Howell (1932) listed Fort Lauderdale as a locality for Scrub Jays. H. Byrd (Biol. Surv. files) reported that Scrub Jays were "tolerably common 15 miles south of Palm Beach and south to Little River," a range that includes all of eastern Broward Co.

Four Scrub Jays were reported on the 1968 Fort Lauderdale summer bird count (Stevenson 1969), and 3 on the 1969 summer bird count in

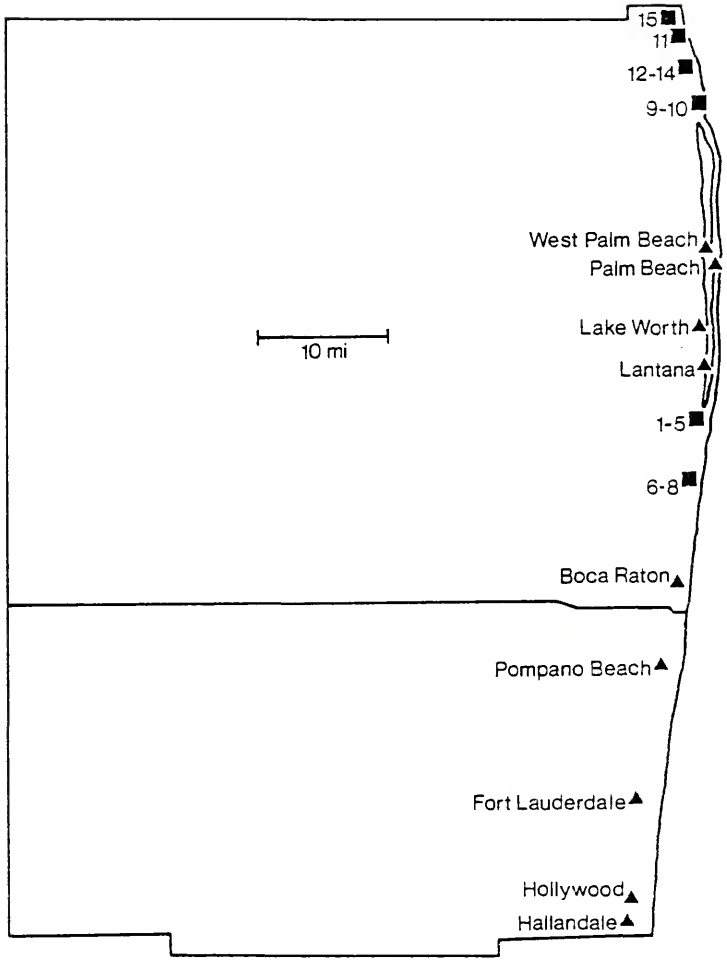

Figure 4. Locations of Scrub Jay records in Broward (bottom) and Palm Beach (top) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations.

Fort Lauderdale (Stevenson 1970a). Scrub Jays were recorded in small numbers (6 or fewer) on almost all Fort Lauderdale Christmas Bird Counts from 1959-1973, but none have been recorded on Christmas counts since then.

B. Humphreys (in litt.) reported that there was a small population of Scrub Jays in northern Fort Lauderdale until the area was developed in the mid-1960's. One or two families of jays lived behind a house at 1215 NE 11th Avenue in Fort Lauderdale until about 1975, when they disappeared (Mrs. T. S. Christensen, in litt.). W. George (pers. comm.) reported that the last Scrub Jays in Pompano Beach were seen about 1974.

Present. It is not clear whether Scrub Jays were ever very common in Broward Co., but they were certainly widespread along the eastern edge of the county. There are at present no known populations of Scrub Jays in Broward Co. The last birds evidently disappeared in the mid-1970's. There is very little scrub left (Steinberg 1980), most of it having been cleared for development.

Charlotte County (Figure 5)

Historical. C. E. Doe, in his field notes for 17 May 1929, reported seeing many Scrub Jays at Grove City. Howell (1932) reported Scrub Jays at Punta Gorda. Tame Scrub Jays were reported at New Point Comfort (north of Grove City) by Withers (1939). Austin (1976) stated that Scrub Jays could be found in what I call slash pine scrub between Placida and Grove City. There is one specimen, without date, of a juvenile Scrub Jay from Charlotte Harbor. C. J. Pennock reported that

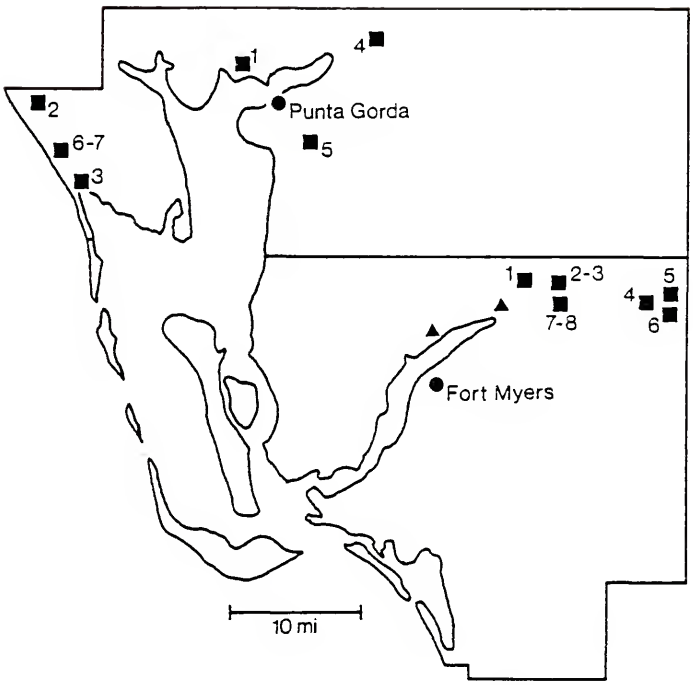

Figure 5. Locations of Scrub Jay records in Charlotte (top) and Lee (bottom) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations; circles--other towns and cities.

Scrub Jays were rare breeders at Punta Gorda (Biol. Surv. files, no date), and M. S. Crosby found 6 Scrub Jays at Punta Gorda in 1926 (Biol. Surv. files).

Present. So far, there have not been significant changes in the distribution of Scrub Jays in Charlotte Co. Jays are still present at or near all of the known historical localities.

Sixteen Scrub Jays were found in 5 different locations in two general areas in 1981. Six jays were found on Shell Creek Loop Road (C-764), northeast of Punta Gorda (Charlotte Co. 4); the rest were found at various places along or near SR 775 between Placida and the Sarasota Co. line (Charlotte Co. 2, 3, 6, and 7). In addition, I have received reports of Scrub Jays at the Port Charlotte development (Charlotte Co. 1), and S. A. Nesbitt (in litt.) has reported Scrub Jays just south of Punta Gorda (Charlotte Co. 5). Much of the scrub at the Port Charlotte development has already been cleared, and most of the rest will probably be cleared in a few years. Some of the areas along SR 775 (e.g., near Wildflower Golf Course) will probably also be developed soon. There are few signs of active or impending development along Shell Creek Loop Road; it is possible that in a few years this will be the only viable population of Scrub Jays in the county.

Citrus County (Figure 6)

Historical. There is one specimen of a Scrub Jay collected at Crystal River in 1969. One Scrub Jay was seen on the 1981 Floral City Christmas Bird Count, the first count made at that location. Four jays were seen on the 1982 count. Scrub Jays have also been reported on US 19-98 near the Cross-Florida Barge Canal (L. F. Snyder, in litt.).

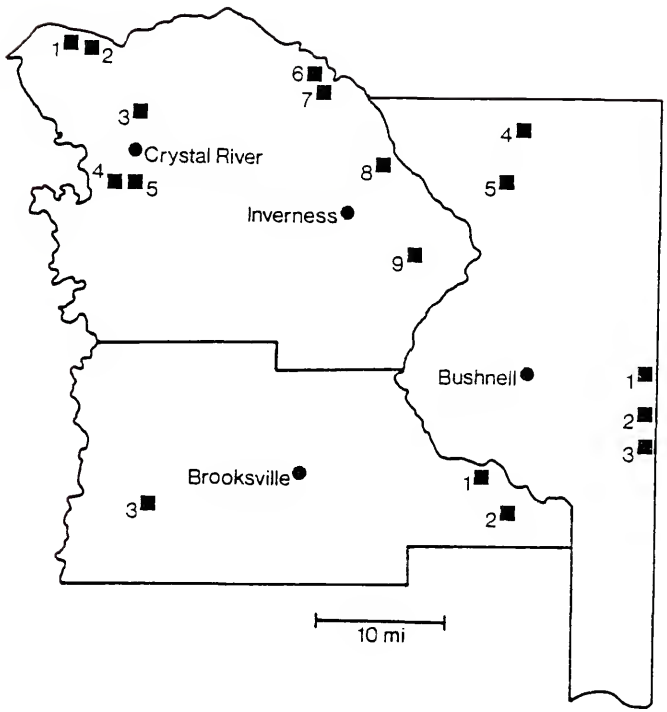

Figure 6. Locations of Scrub Jay records in Citrus (upper left), Hernando (lower left), and Sumter (right) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); circles--other towns and cities.

Present. Nine populations of Scrub Jays are known in Citrus Co. The largest population was found inland near the Crystal Manor development (Citrus Co. 1 and 2) north of Crystal River. Single birds or small groups were found at sites near Crystal River (Citrus Co. 3, 4, and 5), north of Hernando (6 and 7), and northeast of Inverness (8). Scrub Jays are also present on the McGregor Smith Scout Reservation southeast of Inverness (Citrus Co. 9; P. C. Anderson, Ranger, in litt.), the only protected population of jays in the county. The Crystal Manor site is being developed, but progress appears to be rather slow. The other sites do not appear to be in imminent danger of development, but single families can hardly be considered viable populations. In addition to the jays on the scout reservation, it is likely that there will always be a few scattered pairs of Scrub Jays in Citrus Co.

Clay County (Figure 7)

Historical. One Scrub Jay was seen at Keystone Heights in 1965 (Stevenson 1965). Six Scrub Jays were recorded on the Keystone Heights-Melrose Christmas Bird Count in 1966, the only year that count was made. The birds could have been at Gold Head Branch State Park, or near Putnam Hall, Putnam Co. Two specimens were collected at Camp Blanding Military Reservation in 1975.

Present. The Scrub Jays at Camp Blanding were located on the southeast side of Kingsley Lake (J. Greene, pers. comm.). I did not find any jays at that site in 1981. J. Greene (in litt.) said he had not seen any jays there since about mid-1980, and that the site had not

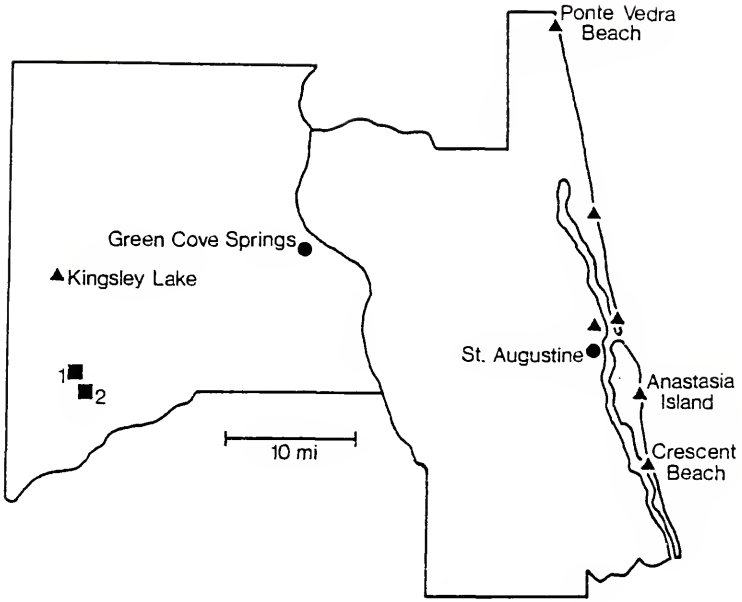

Figure 7. Locations of Scrub Jay records in Clay (left) and St. Johns (right) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations; circles--other towns and cities.

been burned since about 1960. Some of the site is quite dense and overgrown with vegetation, while other areas have been heavily disturbed and have little or no vegetation left. Three Scrub Jays were seen along SR 21 on the southeast side of Camp Blanding (Clay Co. 1) in an area with planted slash pines. This small population cannot be expected to survive long.

The only significant Scrub Jay population known in Clay Co. is at Gold Head Branch State Park (Clay Co. 2) and on adjacent private property. That population is the northernmost one remaining in Florida. One or two families of jays live in the park, and there may be several more on the private property. The private property would make an excellent addition to the park.

Collier County (Figure 8)

Historical. Christy (1928) found a pair of Scrub Jays at Immokalee in 1927, and Sprunt (1946) also reported that Scrub Jays had been found there. C. A. Mitchell recorded Scrub Jays at "Naples, Lee Co." in March 1924 (Biol. Surv. files). Naples was in Lee County until 1923, when Collier Co. was formed from part of Lee Co. Mitchell may have just had an old map. Howell (1932) and Sprunt (1946) both mentioned Naples as a Scrub Jay locality, presumably referring to Mitchell's record. Sprunt (1946) also reported a single record of a Scrub Jay on Marco Island in 1936.

There are 3 Scrub Jay specimens collected in or near Immokalee in 1921, and 2 specimens taken at Lake Trafford in 1937.

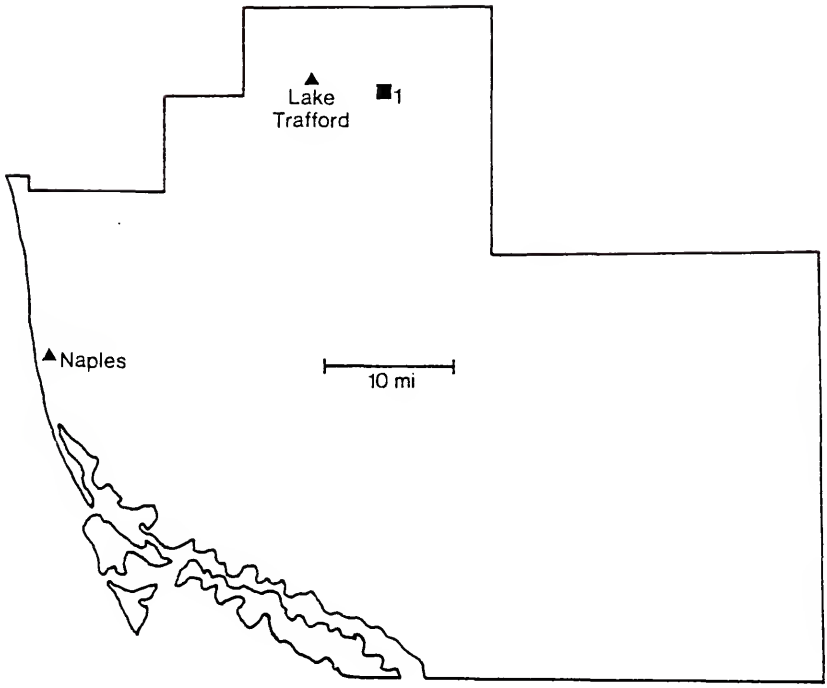

Figure 8. Locations of Scrub Jay records in Collier County, Florida. Square--location of Scrub Jay population, 1980-1983 (number refers to list of sites in Appendix); triangles--former Scrub Jay populations.

One Scrub Jay was seen on the 1980 Corkscrew Swamp Sanctuary Christmas Bird Count, and 2 jays were seen on the 1981 count. None was found on the 1982 count.

T. H. Below (in litt.) found a Scrub Jay nest, attended by 3 adults, near Immokalee in the early 1970's, in an area that has since been developed. Below has never seen a Scrub Jay in Naples since moving there in the early 1960's.

Present. A small population of Scrub Jays is present on the west side of the Immokalee Airport (Collier Co. 1; E. Cutlip MS). As many as 10 jays were seen there at one time in 1980 (E. Cutlip, pers. comm.). This property is in owned by Collier Co., and the population could survive indefinitely.

Dade County (Figure 9)

Historical. Oberholser (1920) reported Scrub Jays at Miami, but Bailey (1932) reported jays only as far south as Lemon City. Sprunt (1946) wrote that Scrub Jays could be found as far south as Miami, but added that "many observers have not noted them" so far south (p. 78).

There are 7 Scrub Jay specimens collected between Ojus and North Miami from 1896 to 1933. Another specimen was collected at North Miami in 1962. One egg set was secured at Miami in 1910, 3 were collected at Lemon City in 1922 and 1923, and 3 more were collected at Little River in 1923 and 1924. One egg set was taken at an unspecified Dade Co. location in 1923, and one specimen was collected at an unspecified Dade Co. location in 1936. S. S. Cott, who collected a specimen at Ojus in winter 1896-97, noted on the label that Scrub Jays were "rather common among Scrub-pines."

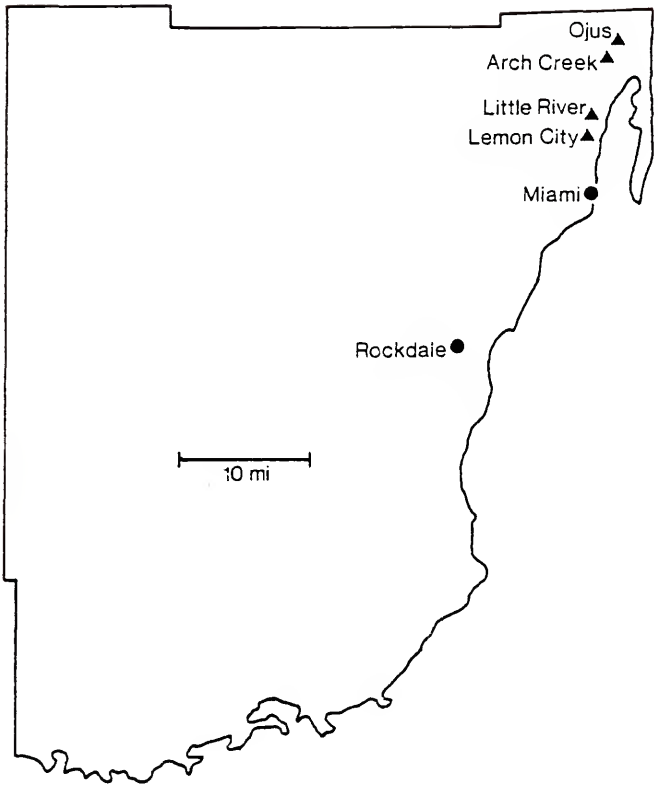

Figure 9. Locations of Scrub Jay records in Dade County, Florida. Triangles--former Scrub Jay populations; circles--other towns and cities.

J. and H. Quincy (in litt.) reported that 1-2 Scrub Jays were seen daily from 1953-57 at the corner of NW 125th St and 7th Ave in North Miami, but that they are all gone now. O. Owre (pers. comm.) stated that Scrub Jays have been gone from Dade Co. for "years and years." See comments concerning Rockdale under "Questionable Localities."

Present. Scrub Jays were probably fairly common and widespread in northeastern Dade Co. at one time, but the last ones apparently disappeared in the 1960's. The cause of the disappearance was habitat destruction. There are now no Scrub Jays in Dade Co., and little if any scrub.

DeSoto County (Figure 10)

Historical. A. H. Howell quoted a Mr. Wilkinson as saying that Scrub Jays "occur near Fort Ogden" (Biol. Surv. files, 1918).

Present. Scrub Jays are known from two locations in DeSoto Co.: along the Manatee Co. line, northwest of Arcadia (DeSoto Co. 1, continuous with Manatee Co. 3); and on the Bright Hour Ranch, southeast of Arcadia (DeSoto Co. 2). Both sites could support Scrub Jays indefinitely.

I know of no DeSoto Co. Scrub Jay populations near Fort Ogden, but jays are present a few miles south of Fort Ogden in Charlotte Co. (Charlotte Co. 4).

Dixie County

Historical. See Gilchrist Co.

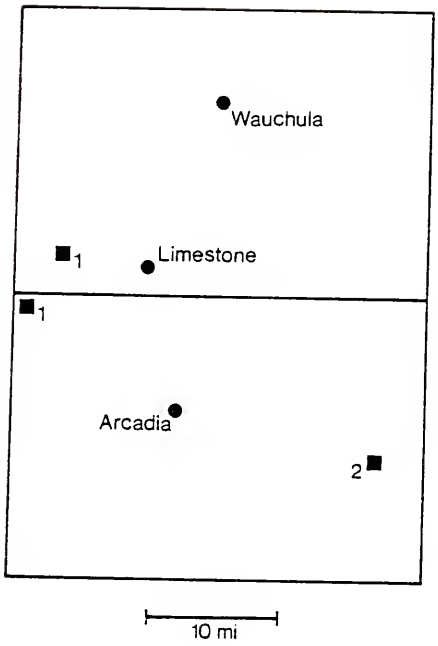

Figure 10. Locations of Scrub Jay records in DeSoto (bottom) and Hardke (top) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); circles--other towns and cities.

Duval County (Figure 11)

Historical. Ord (1818) wrote that Scrub Jays were seen daily in February and March 1818 in thickets near the mouth of the St. Johns River. Howell (1932) likewise reported Scrub Jays at the mouth of the St. Johns River, and Oberholser (1920) stated that they were resident in low scrub north to Jacksonville. E. R. Greene saw 4 Scrub Jays in 1924 between Pablo Beach (near the intersection of US 90 and SR A1A) and Atlantic Beach, and 2 Scrub Jays in 1925 between Pablo Beach and Neptune (Biol. Surv. files).

Grimes (1932) found Scrub Jays nesting at Jacksonville Beach and Neptune in 1931. Later, Grimes (1940, 1943, and in Sprunt 1946) stated that there had been 4-5 pairs in the Jacksonville Beach area in 1930, but that they had all disappeared by 1940. He attributed the disappearance solely to the clearing of scrub for development.

One Scrub Jay egg set was collected at Jacksonville Beach in 1933.

One Scrub Jay was seen in coastal Jacksonville on the 1948 Christmas Bird Count. Scrub Jays were not seen again on a Jacksonville Christmas Count until 1972, when one was seen on Talbot Island. A Scrub Jay was present for 3-4 months in 1970 in scrub between the Jacksonville Beach hospital and the Jacksonville Beach Golf Club (S. A. Grimes, in litt.). A single jay seen on the University of North Florida campus in 1978 was said to have been the first one in Duval Co. in 6 years (Kale 1978b), but S. A. Grimes (in litt.) has informed me that a family of Scrub Jays was present in scrub south of SR 202 (J. Turner Butler Blvd), about 1 and 1/2 miles west of SR A1A in Jacksonville Beach in winter 1974-75.

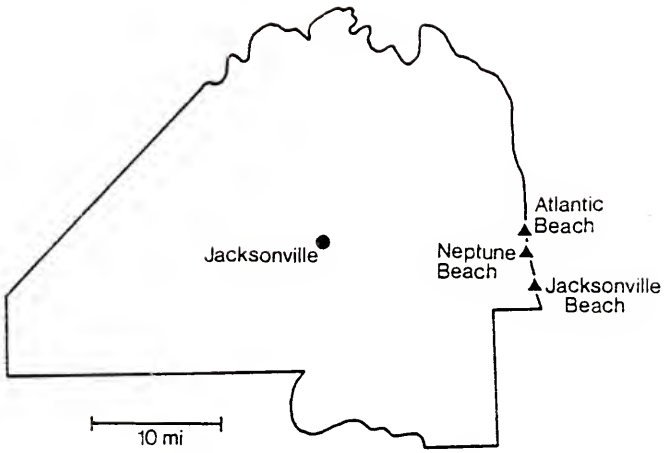

Figure 11. Locations of Scrub Jay records in Duval County, Florida. Triangles--former Scrub Jay populations; circle--other city.

Present. Scrub Jays were extirpated as breeding birds from Duval Co. in the 1940's or 1950's. The jays occasionally reported from the county are most likely non-breeding vagrants from farther south or southwest in Florida. As a result of urban development, there is very little scrub left in Duval Co.

Flagler County (Figure 12)

Historical. In Flagler Co., Scrub Jays have been reported from Bulow (2 specimens, 1925); in the vicinity of Flagler Beach (Lane 1981; and one specimen, 1929); 7 miles north of Flagler Beach (one specimen, 1972); near Marineland (Hundley 1964; Stevenson 1970b; Steffee and Mason 1971c; Lane 1981; and one specimen, 1958); and Matanzas Island (one specimen, 1950).

Concerning the two specimens collected at Bulow in 1925, A. H. Howell noted that in the area where the birds were collected, Scrub Jays "were numerous in oak and palmetto scrub on the beach" (Biol. Surv. files). Stevenson (1970b) wrote that the northern limit of the range of Scrub Jays in 1970 was at Marineland, although they had previously been found north to Duval Co.

Five Scrub Jays were seen on the 1972 Christmas Bird Count at Flagler Beach. No other Christmas counts have been conducted in Flagler Co.

Present. Scrub Jays are still present just south of Marineland (Flagler Co. 2) and at Flagler Beach State Recreation Area (Flagler Co. 1). The population at Flagler Beach SRA has, however, declined from 3-4 pairs in the mid-1970's to a single family in 1981, due to

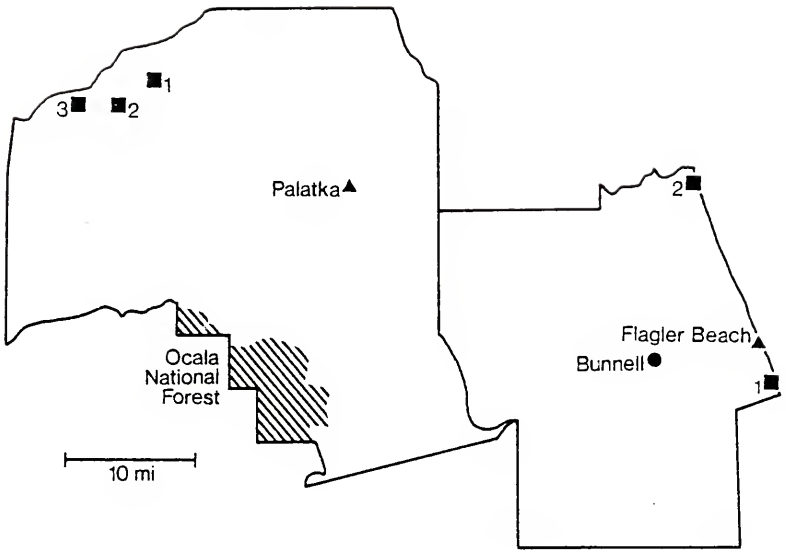

Figure 12. Locations of Scrub Jay records in Flagler (right) and Putnam (left) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations; circle--other town.

clearing of nearby scrub for development (C. Thorndike, Ranger, pers. comm.). There are still extensive areas of scrub along the Atlantic coast in Flagler Co., and some of these areas may still support Scrub Jays. Most of that scrub is privately owned, however, and therefore subject to development. (One large development is currently being planned for the coastal area, about 4 miles south of Marineland.)

Scrub along SR A1A between Marineland and Washington Oaks Gardens State Park (Flagler Co. 2) would make an excellent preserve.

Gilchrist County (Figure 2)

Historical. A. P. Smith reported Scrub Jays from Wannee on 10 Jan 1901 (Biol. Surv. files), and Howell (1932) listed Wannee as a location for Scrub Jays.

Present. I could not find any scrub or Scrub Jays in Gilchrist Co. There is, however, a tract of oak scrub in Dixie Co. about 3 miles southwest of Wannee, across the Suwannee River. This tract could be the location of the Wannee records, or it may merely be the last remnant of scrub that was once more widespread around Wannee.

Glades County (Figure 13)

Historical. The only historical locality reported in the literature for Scrub Jays in Glades Co. is along Fisheating Creek (Evans 1923; Howell 1932; Sprunt 1946; Lane 1981). There is one Scrub Jay specimen from Fisheating Creek in 1891, one from Palmdale in 1975, and 2 specimens collected at unspecified Glades Co. localities in 1930.

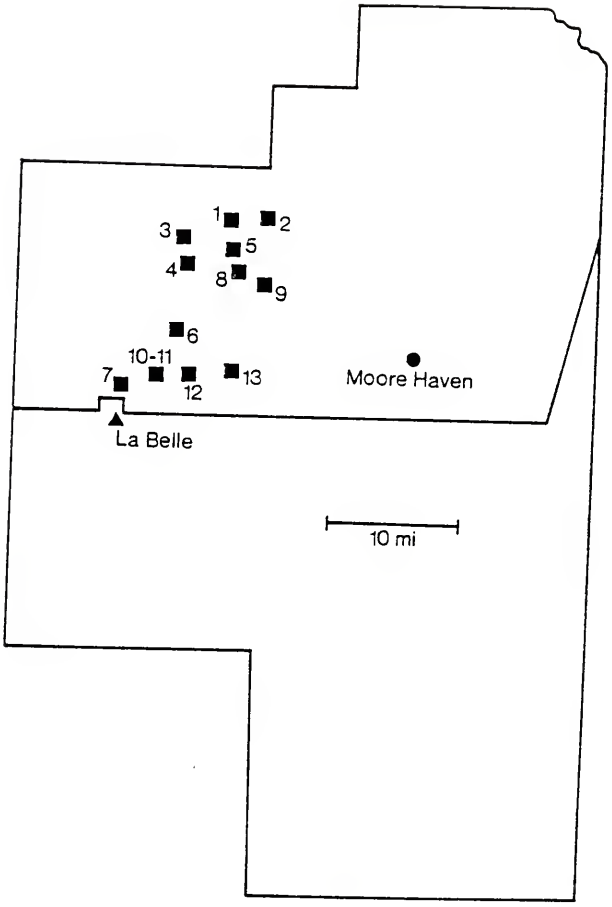

Figure 13. Locations of Scrub Jay records in Glades (top) and Hendry (bottom) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangle--former Scrub Jay population; circle--other town.

Present. Scrub Jays can be readily seen along SR 74, west of US 27, in the Fisheating Creek Wildlife Management Area (Glades Co. 4). Scrub Jays are also present on several other areas of Fisheating Creek WMA (Glades Co. 2, 3, and 9). The greatest numbers of jays are on the north and south sides of Fisheating Creek itself, west of US 27. I estimate the total Scrub Jay population at Fisheating Creek WMA to be about 150 birds. That population should be preserved if at all possible. Although the scrub in those areas is part of a wildlife management area, it is nevertheless privately owned, and some of the scrub has been cleared for cattle pasture in the past few years. (It is conceivable that in the absence of fire, clearing of small patches of scrub might actually prove beneficial to Scrub Jays by providing openings in the habitat and preventing the vegetation from growing too tall. Scrub Jays would benefit, however, only if each parcel of scrub were allowed to regenerate for 8-10 years before being cleared again, and if no non-scrub plants were planted. I cannot recommend mechanical clearing of vegetation as a general management technique, but it might prove useful in a few cases, and having Scrub Jays in a cow pasture is preferable to having no jays at all.)

Scrub Jays are also present at low densities near Palmdale (Glades Co. 1, 5 and 8), and at various places along SR 29 (6 and 7) and SR 78 (10-13). With the possible exception of the site east of Palmdale (5) and the one at the Ortona Cemetery (13), these sites do not seem likely to be developed, but the Scrub Jay populations are small and widely dispersed, and cannot be considered stable.

Hardee County (FIgure 10)

Historical. One Scrub Jay was seen at stop 41 of the Fort Lonesome (southeastern Hillsborough Co.) Breeding Bird Survey in 1972. Stop 41 is on SR 64, probably just east of the Manatee Co. line, in Hardee Co. (However, depending on exactly where the observer stopped that year, stop 41 could have been a half-mile or more east or west of its proper location, even in Manatee Co.)

Present. One small population of Scrub Jays was found west of Limestone (Hardee Co. 1) in 1981. This population lives in a mosaic of pastures and various types of scrub. There were no obvious indications that any of that scrub will be cleared in the near future. There are probably other small populations of Scrub Jays in southwestern Hardee Co.

I have been unable to find any jays or scrub along SR 64 east of the Manatee Co. line. There is some scrub along SR 64 in Manatee Co., just west of the Hardee Co. line, but I have found no jays there, either.

Hendry County (Figure 13)

Historical. There are six Scrub Jay specimens from Fort Thompson (near LaBelle), collected 1891-92, and one from LaBelle in 1937. Howell (1932) also reported Scrub Jays from Fort Thompson.

E. S. Clark (in litt.) saw one Scrub Jay 20 December 1980 near the junction of SR 80 and SR 78A, about 5 miles southwest of LaBelle.

Present. I found no Scrub Jays in Hendry Co. in 1981, and only a few small areas of slash pine scrub and poor quality oak scrub. I

conclude that there are no viable Scrub Jay populations in Hendry Co. at the present time.

Hernando County (Figure 6)

Historical. Ten Scrub Jays were seen on the Hernando Co. Summer Bird Count in 1969 (Stevenson 1970a). Westcott (1970) did not find any jays at the Weeki Wachee scrub in 1969-70, but he felt that some of the habitat would be suitable for Scrub Jays.

Present. The Weeki Wachee scrub (Hernando Co. 3) burned in June 1971, and at least one or two families of Scrub Jays are resident there now. The jays may have dispersed to Weeki Wachee on their own, but S. B. Fickett (pers. comm.) has told me that the Scrub Jays were released in that area in the 1970's by a local resident. The birds are reproducing there, which indicates that it might be relatively easy to establish new Scrub Jay populations elsewhere in the state, if that story is true. The Weeki Wachee scrub is quite extensive, with few signs of active development, but that situation could change quickly. In addition, the sand pines are regenerating in many areas of the scrub, and are now reaching heights of 6 meters or more. If the area is not burned in the next few years, Scrub Jays might disappear due to vegetational succession, even if the area is not developed.

Several Scrub Jays are present at Ridge Manor Estates (Hernando Co. 1), north of the town of Ridge Manor. This development covers several hundred acres and has an extensive network of roads, but I saw very few new houses, or houses under construction. The jays, therefore, seem relatively safe for the time being, but the development could begin growing quickly at any time.

A few Scrub Jays inhabit the western portions of Richloam Wildlife Management Area (Hernando Co. 2), and this small population may persist indefinitely.

Highlands County (Figure 14)

Historical. Totals of 105 specimens and 26 egg sets of Scrub Jays have been collected in Highlands Co. The specimens are from Lake Istokpoga (2, 1893; 2, 1973); the Lake Placid-Childs-Hicoria area (5, 1928; 2, 1945-47; 7, 1950-59; 29, 1960-69; 46, 1970-79; 2, 1980); about 8 miles northwest of Lake Placid (1, 1980); Lorida (2, 1961); near Sebring (1, 1972); 6 miles east of Sebring (2, 1923); Venus (1, 1960); and unspecified Highlands Co. locations (one each in 1959, 1961, and 1973). Of the birds collected between Lake Placid and Hicoria, approximately half were collected north of SR 70, and half south of SR 70. The egg sets include 5 from Sebring in 1923, and 21 from Lake Placid and Childs, 1927-31.

The specimen localities include all sites mentioned in the literature (Howell 1932; Pitelka 1951; Westcott 1970) except for a population of Scrub Jays at Highlands Hammock State Park (Hundley 1964; Steffee and Mason 1971a; Lane 1981).

G. E. Woolfenden, J. W. Fitzpatrick, and their colleagues have been conducting intensive studies on a population of Scrub Jays at Archbold Biological Station, about 8 miles south of Lake Placid, since 1969 (Stallcup and Woolfenden 1978; Woolfenden 1973, 1975, 1976, 1978b; Woolfenden and Fitzpatrick 1977, 1978, MS).

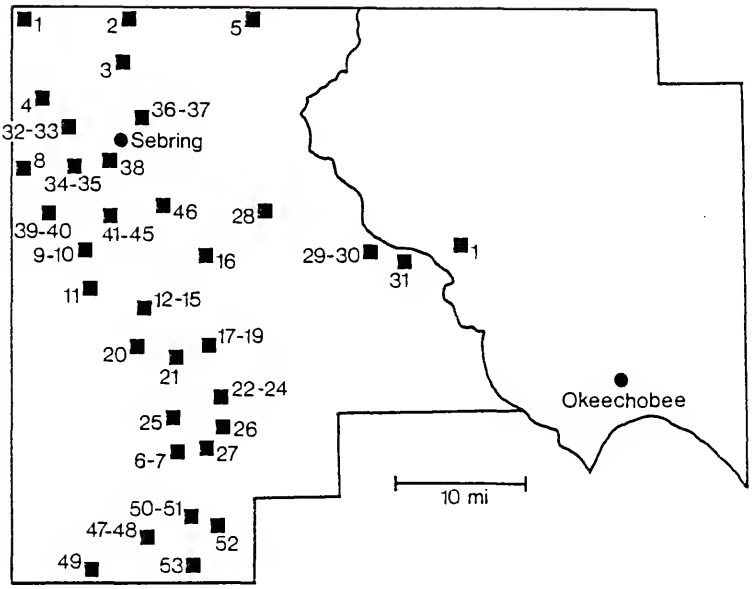

Figure 14. Locations of Scrub Jay records in Highlands (left) and Okeechobee (right) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); circles--other towns and cities.

Scrub Jays have been seen at one time or another on more than two-thirds of the stops on the Lake Placid Breeding Bird Survey. Jays have been most frequently seen along Old SR 8 (= SR 17) between SR 70 and SR 731.

Present. Totals of 302 adult and 75 juvenile Scrub Jays were seen at over 50 locations in Highlands Co. outside of Archbold Biological Station in 1981. All but three of the populations were located within 6 miles of US 27, which runs roughly down the center of the Lake Wales Ridge. Scrub Jays were found at all known historical locations, but it is evident that much scrub has been cleared, especially along US 27. For example, along US 27 between SR 70 and Venus (Highlands Co. 27), about 65% of the natural vegetation has been cleared for citrus groves. All of the remaining natural vegetation is scrub, indicating that scrub was the major, if not the only, type of natural vegetation in that area. North of SR 70 on US 27, scrub was probably intermixed with other vegetation types, but was still a major component of the vegetation. Very little natural vegetation of any type is left along US 27 between SR 70 and the Polk Co. line, although Scrub Jays are still present in some of the scrub that is left (Highlands Co. 22, 27). I conclude, therefore, that Scrub Jays have declined significantly in Highlands Co., due to habitat destruction, even though the trend cannot be verified with historical records.

Scrub Jays will continue to decline in Highlands Co. as development proceeds. At least 8 sites (Highlands Co. 1, 3, 4, 12, 20, 23, 24, and 38) show clear signs of development. Only the small populations at Avon Park Bombing Range (5) and Highlands Hammock State

Park (8), and the large population at Archbold Biological Station (6), are adequately protected. No doubt some of the other unprotected areas will be developed in the future, but a large amount of scrub will still be present in Highlands Co., just because there was so much of it to begin with. The area likely to suffer the most damage from clearing, other than the known housing developments, is along US 27 south of SR 70, as the scrub is cleared for citrus groves.

Using the Highlands Co. soil survey (Soil Conservation Service 1952), I estimated that prior to the development of Highlands Co., there may have been as much as 4000 hectares (10,000 acres) of scrub south of SR 70, excluding Archbold Biological Station (ABS). That area represents the extreme southern end of the Lake Wales Ridge. Some of the scrub would have been sand pine scrub, but most would have been suitable Scrub Jay habitat. Assuming that 65% of that scrub has been cleared, as it has along US 27, about 1400 ha (3500 ac) of scrub remain. Further assuming that the Scrub Jay density at ABS--about 10 birds/40 ha--is average for that whole area, I derive a population of 350 Scrub Jays for the area. The undisturbed portions should be preserved if at all possible.

It is difficult to estimate the Scrub Jay population sizes in other portions of Highlands Co. because the scrub is intermixed with other habitats. Considerable scrub remains near Lake Placid, although development is already taking place in most of the large tracts of scrub. Nevertheless, in 1981, I found about 180 Scrub Jays within about 6 miles (10 km) of Lake Placid, north of SR 70, and I estimate that there are about 300 birds in that area.

In 1979, all "adult-plumaged" Scrub Jays at Archbold Biological Station were counted during the breeding season (Woolfenden and Fitzpatrick MS). A total of 388 jays in 144 groups was found. Since then, another small tract of scrub (and a lake) have been added to the station property, so the continued existence of about 400 jays at ABS seems likely. Most of the scrub on the station is burned periodically, maintaining its suitability for Scrub Jays.

Woolfenden and Fitzpatrick have color-banded almost all of the Scrub Jays on their study area at ABS, so that they can track the lives of individual birds. I made a special effort to check for color-banded Scrub Jays in Highlands Co., but found none outside of Woolfenden and Fitzpatrick's study area, indicating a very low rate of dispersal.

Three sites in Highlands Co. should be considered as candidates for preservation: a site on the west side of Lake Istokpoga, northeast of Lake Placid (Highlands Co. 16); an area about 9 miles southeast of Lorida on US 98 (30); and east and west of US 27, south of SR 70 (27). Preservation of some scrub along US 27 is especially important, to provide a buffer zone for the Archbold scrub.

Archbold Biological Station will always support a large population of Scrub Jays, but jays will continue to decline in other parts of Highland Co. as more scrub is cleared.

Hillsborough County (Figure 15)

Historical. There are few records of Scrub Jays in Hillsborough Co. Reynolds (1910) wrote that he had seen "quite a number" of Scrub Jays at an unspecified location in "Hillsbrook County" (p. 132), which

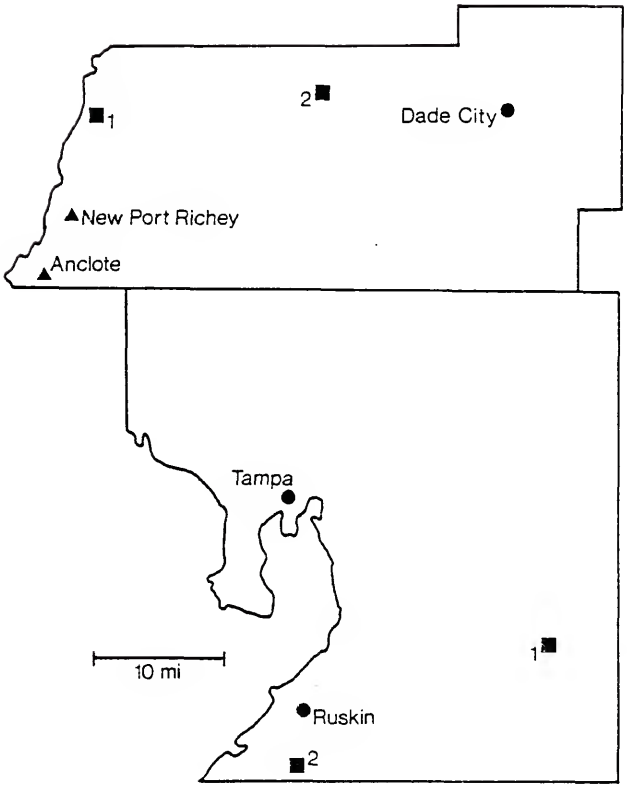

Figure 15. Locations of Scrub Jay records in Hillsborough (bottom) and Pasco (top) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations; circles--other towns and cities.

I assume refers to Hillsborough County. Baynard (1942) reported that there were only four records of Scrub Jays in 20 years at Hillsborough River State Park. A member of the Florida Ornithological Society reported that there were Scrub Jays near Ruskin in the early 1970's (anon., pers. comm.).

Present. I found no Scrub Jays in Hillsborough Co. in 1981, and have received only two recent reports of jays in the county: just north of Picnic (Hillsborough Co. 1); and southeast of Ruskin (2). There are several tracts of scrub, especially in the southern half of the county, and some of them may support small numbers of Scrub Jays.

Indian River County (Figure 16)

Historical. Between 1896 and 1911, 13 Scrub Jay specimens were collected at Sebastian. One egg set was taken near Roseland in 1925, and 3 specimens were collected near the Roseland fire tower in 1973.

Two Scrub Jays were seen on the 1967 Vero Beach Summer Bird Count (Stevenson 1968). Scrub Jays were seen on all Vero Beach Christmas Bird Counts from 1965 to 1973, except one, with a maximum of 12 in 1972. No Christmas Bird Counts have been made in the Vero Beach area since 1972. Scrub Jays were seen every year from 1966-82 on the South Brevard Co. Christmas count, which includes the northeastern part of Indian River Co. Some Scrub Jays were probably seen in Indian River Co. on each count, but the exact numbers are unknown.

M. C. Bowman (pers. comm.) has informed me that Scrub Jays were once present on the barrier island, but have been gone for many years.

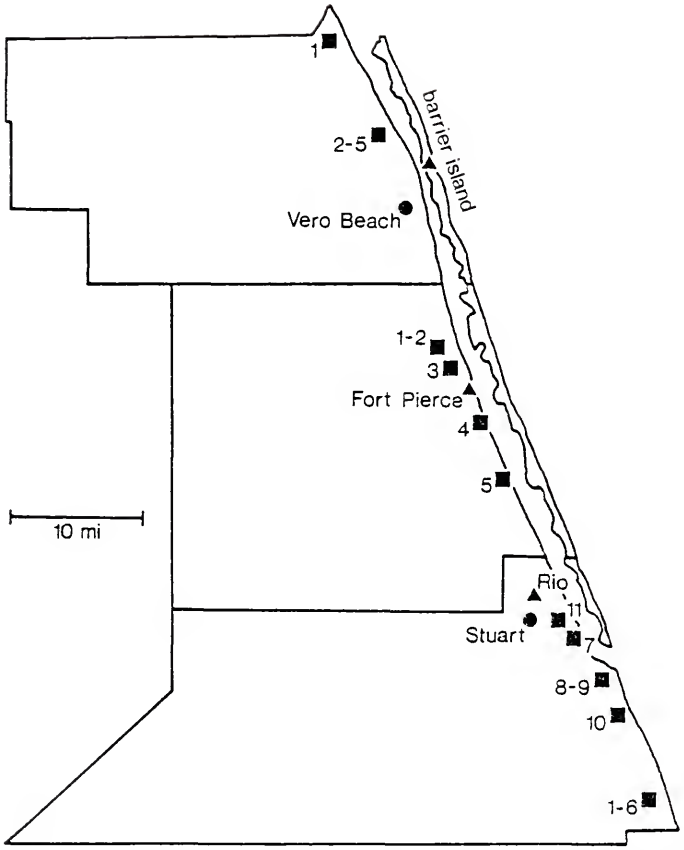

Figure 16. Locations of Scrub Jay records in Indian River (top), Martin (bottom), and St. Lucie (center) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations; circles--other towns and cities.

Present. I found eleven Scrub Jays at four places (Indian River Co. 1-3, 5) in Indian River Co. in 1981, and I have received a report of Scrub Jays at one other location (4). The populations are located at Roseland and near Winter Beach.

There may be a few other undetected populations. Scrub Jays are still present at or near the known historical locations, except for the barrier island, but they have declined as a result of habitat destruction. The scrub at Roseland (Indian River Co. 1) is unlikely to be cleared in the near future, and probably supports more than the 3 jays I found there. The other 4 sites cannot be expected to remain intact indefinitely.

Lake County (excluding portions in Ocala National Forest) (Figure 17)

Historical. Keck (1903) reported that Scrub Jays were very rare in the vicinity of Fruitland Park. Bosanquet (1927) wrote that Scrub Jays were present in Lake Co., especially in "scrub lands." The field notes of C. E. Doe indicate that he found Scrub Jays about 5 miles south of Leesburg in 1932, and in the area between Eustis, Mount Dora, and Tavares in 1938-1940. F. M. Walker reported "an abundance" of Scrub Jays between Tavares and Leesburg (Biol. Surv. files, 1922).

There are three Scrub Jay specimens collected one mile south of Sorrento in 1950, one from Eustis in 1934, one from 4.5 miles south of Okahumpka in 1964, and two egg sets from between Tavares and Eustis, dated 1939 and 1942.

Scrub Jays were seen on every Mount Dora Christmas Bird Count (including those listed as Tangerine-Mount Dora) from 1955 to 1982. A

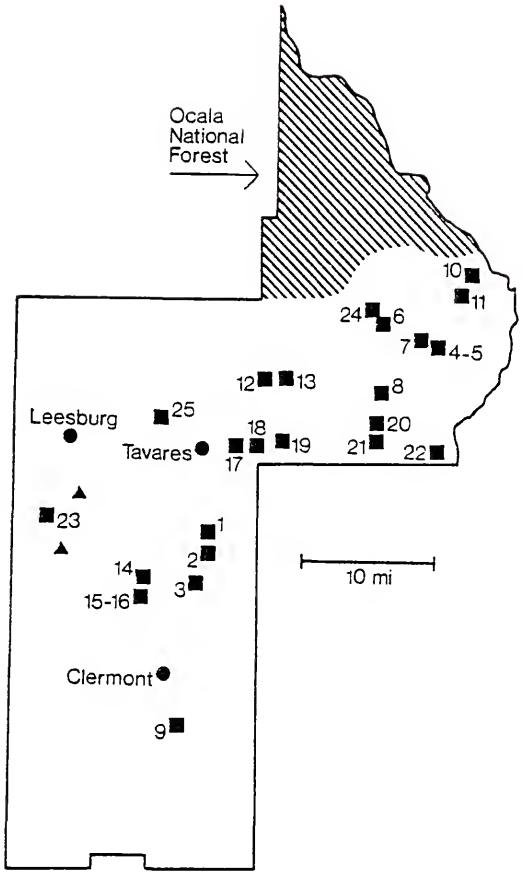

Figure 17. Locations of Scrub Jay records in Lake County, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations; circles--other towns and cities.

high of 28 Scrub Jays was seen in 1965, but no more than 11 have been seen on any count since 1976. The Mount Dora CBC circle includes part of Orange Co., and some of the Scrub Jays in each year were probably seen in Orange Co.

Brigham (1973) wrote that the Scrub Jay population in the Mount Dora area had declined due to habitat destruction for housing developments. She could find only one pair of jays in Mount Dora, where there had been 6-8 pairs five years previously.

Scrub Jays have been recorded regularly at stops 26-29 on the Mabel (Sumter Co.) Breeding Bird Survey. Those stops are on SR 48, roughly 1.1-2.6 miles SW of Florida's Turnpike.

Present. Scrub Jays were found at 25 locations in Lake Co. in 1980 and 1981. The largest populations were found southeast of Astatula (Lake Co. 2), along SR 44 between Cassia and Crow's Bluff (4-7 and 10-11), east of Eustis (13), and south of Howey-In-The-Hills (14). In the areas southeast of Astatula and between Cassia and Crow's Bluff, extensive areas of scrub are being cleared for houses. Recent clearing was also evident at a site south of Clermont (9). Portions of the site east of Eustis (13) have been cleared in the past, but the remainder appears largely undisturbed and could support Scrub Jays indefinitely. Scrub Jays are present at only two locations between Eustis, Tavares, and Mount Dora (17, 18), and at one additional site between Tavares and Leesburg (25). Extensive clearing has occurred around all of those sites and they are not safe from further clearing.

I found no Scrub Jays one mile south of Sorrento, but jays are still present a mile farther south, near Bay Ridge in Orange Co. No

jays were found 5 miles south of Leesburg, or 4.5 miles south of Okahumpka.

Site 23 is close to stop 29 of the Mabel (Sumter Co.) Breeding Bird Survey. A narrow strip of disturbed scrub is present between SR 48 and the Seaboard Coast Line Railway tracks from near Florida's Turnpike, southwest to about 1.5 miles west of the Sumter Co. line (see Sumter Co. 1). Scrub Jays may be distributed continuously along that stretch of scrub; the habitat does not appear to be in danger of being cleared.

The fairly large population south of Howey-In-The-Hills (Lake Co. 14) is in disturbed scrub, and its future cannot be predicted at this time. The remaining Scrub Jay populations are scattered throughout all but the southern quarter of Lake Co. Many of the populations (e.g., at sites 3, 14, 15, 16, 18, 21, and 23) are in disturbed scrub habitats. Because of the apparent ability of Scrub Jays to survive in disturbed habitats, it is likely that there will always be scattered pairs or small populations of Scrub Jays in Lake Co. Scrub Jays will continue to decline as more habitat is cleared, but it is unlikely that they will disappear completely from the county. I expect the population to stabilize at around 100 jays in several years.

Lee County (Figure 5)

Historical. Scrub Jays have been reported in Lee Co. from Alva (Howell 1932; Steffee and Mason 1971b), Fort Myers (Oberholser 1920; Howell 1932), Olga (Steffee and Mason 1971b), Punta Rassa

(Bendire 1895; Howell 1932), and along SR 78 east of SR 31 (Hundley 1964). Scott (1889) reported that Scrub Jays were common along the Gulf coast north of Punta Rassa, but not at Punta Rassa, so there is some doubt as to whether Scrub Jays have ever been resident there.

On several occasions, Scrub Jays have been recorded on the Breeding Bird Survey beginning near Salvista (north Fort Myers area): one at stop 37 and one at stop 47, 1967; 2 at stop 21 and 3 at stop 46, 1968; 3 at stop 21, 1969; 2 at stop 35, 1971; one at stop 26, 1972; one at stop 49, 1973; and three at stop 38, 1977. Stop 21 is on SR 78, about 2 miles northeast of US 41 (Business Route); stop 26 is on SR 78, about 3.5 miles northeast of US 41 (Business Route); stops 35 and 37 are on SR 78, about 1.5 and 0.5 miles, respectively, west and south of SR 31; stop 38 is near the junction of SR 31 and SR 78; stops 46 and 47 are on SR 78, approximately 3.5 to 4.0 miles east of SR 31; and stop 49 is on SR 78, about 5 miles east of SR 31.

Three Scrub Jays were seen on the 1968 Fort Myers Summer Bird Count (Stevenson 1969). Scrub Jays have never been recorded on a Fort Myers Christmas Bird Count (1927, 1955, 1957-1980).

In addition to one specimen secured at Fort Myers in 1892, there are 23 Scrub Jay specimens from Alva, collected between 1891 and 1907, perhaps indicating that Scrub Jays were fairly common there at that time.

There are several records of Scrub Jays in Lee Co. in the files of the old Biological Survey: A person referred to only as "Beers" found Scrub Jay eggs at Alva in 1907. A. H. Howell saw one Scrub Jay north of Fort Myers near the Caloosahatchee River in 1919, and quoted

S. Hanson as saying that Scrub Jays "occur in moderate numbers" in that area. M. S. Crosby noted 2 Scrub Jays at Fort Myers in 1925, and 4 at Alva in 1926.

Present. I found, or received reports of, Scrub Jays at 8 locations in Lee Co. All locations are within 2 miles of the Caloosahatchee River east of Fort Myers. All of the sites are east of SR 31, even though several of the older records are from west of SR 31. A new street was put in one of the Olga sites (Lee Co. 7) in 1979 or 1980, and two of the Alva sites (4 and 6) have evidently also undergone some recent clearing. Scrub Jays could persist indefinitely at the other sites, but due to the limited amount of scrub in Lee Co., it is unlikely that there will ever be more than 30 or 40 Scrub Jays, if that many, in the county.

Levy County (Figure 18)

Historical. Ninety Scrub Jay specimens have been collected in Levy Co. Of that number, 77 were collected in the Cedar Key-Lukens-Sumner-Rosewood area from 1870-1908, one was collected at "Cedar Keys" in 1926, 6 were collected near Rosewood or Sumner from 1952 to 1964, 3 were collected at Cedar Key in 1964-65, and one was collected at Cedar Key in 1970. Single specimens were collected at Yankeetown in 1959 and 1964. One egg set was collected at "Cedar Keys" in 1894, and another was collected "about three miles east [=north?] of Cedar Key" in 1935. The Cedar Key, Lukens, Rosewood, and Sumner specimens are all referable to a single, large population found within a few miles north of what is now the junction of SR 24 and SR 347.

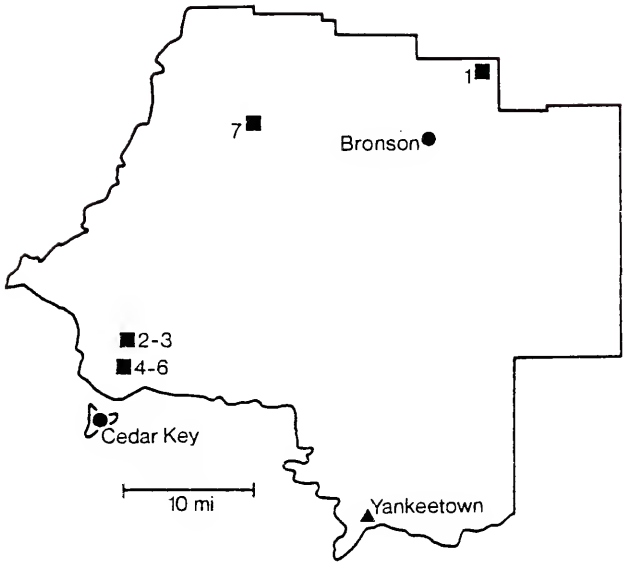

Figure 18. Locations of Scrub Jay records in Levy County, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangle--former Scrub Jay population; circles--other towns and cities.

Howell (1932) reported that Scrub Jays had been found at Cedar Key and Sumner. Maynard (1881) wrote that he had found Scrub Jays "in quite large flocks on the mainland opposite Cedar Keys" (p. 165).

It is not clear whether Scrub Jays were ever present at Cedar Key proper, or if Cedar Key was just used as a general term, referring to the Rosewood-Sumner-Lukens area. For example, even though Maynard (1881) wrote that Scrub Jays were common "on the mainland opposite Cedar Keys," he gave the location of specimens he collected in the area as "Cedar Keys."

Seventeen Scrub Jays were found on the 1979 Christmas Bird Count at Cedar Key, 6 on the 1980 count, 13 on the 1981 count, and 26 in 1982.

Present. Scrub Jays were found in 3 areas of Levy Co. in 1981: northeast of Bronson (Levy Co. 1); south of Chiefland (7); and north of Cedar Key (2-6). I did not find any jays at Yankeetown.

Very little scrub is left at Yankeetown, but some scrub is still present near Rosewood and Sumner. The Rosewood-Sumner scrub appears too tall and dense to be suitable for Scrub Jays, however, probably due to the absence of fire for over 25 years (see below).

The Bronson site is on private property, and the jays may survive there indefinitely. Some of the land at the Chiefland site has been cleared for houses recently, and the rest may follow in a few years.

Portions of the Cedar Key scrub are owned by the State of Florida as the Cedar Key Scrub State Preserve (Levy Co. 5 and 6), and the future of Scrub Jays on that land is assured as long as proper management techniques are followed. An extensive wildfire burned most

of the Cedar Key scrub in the mid-1950's, and some of the areas have not been burned since then. As a result, portions of the scrub are too dense and overgrown to provide suitable Scrub Jay habitat. Burning of the scrub on a 5-10 year cycle should improve the quality of the habitat for the jays. I found 20-21 Scrub Jays on the state preserve in 1980 and 1981, and estimate that there are no more than 30 or 40 jays on the preserve. This number could probably be increased through judicious burning.

Most of the private property around the state preserve is relatively undisturbed, although some land has been cleared in the last five years for projected housing developments. Some of the best Scrub Jay habitat in the area is privately owned and posted "For Sale"--Sec 4, T15S, R13E (Levy Co. 4). I counted almost 20 Scrub Jays in that one section in March 1981. Most of the birds were west of SR 347. A few lots along SR 347 were cleared in 1982. Section 4 is bordered on three sides by the state preserve; it should be protected from development if at all possible.

I saw a total of 35 Scrub Jays on private lands in the Cedar Key area in 1981, and estimate that about that many more went undetected. If site 4 remains relatively undisturbed, a total population of about 100 Scrub Jays might be sustained in all of the Cedar Key scrub. If site 4 and other areas are developed, the total might be as low as 40-60 birds.

Manatee County (Figure 19)

Historical. There are 6 Scrub Jay specimens from Manatee Co.--one from Manatee in 1876, 2 from "Sneeds [sic] Island" in 1889, and 3 from unspecified locations, 1884-1898. One batch of 8 eggs was collected at Manatee (date unknown).

Byrd (1927) wrote that Scrub Jays had been "fairly abundant" in Manatee Co. in 1925, but added that the clearing of much of the scrub in 1924 for subdivisions had caused the population size to decrease. Earlier, Byrd (Biol. Surv. files, 1918) had reported that Scrub Jays occurred a little south of Bradenton.

Scrub Jays were seen on the Palma Sola Christmas Bird Count in 1908, 1910, 1912, 1925, and 1929. One Scrub Jay was seen on the Northwest Manatee Co. Christmas Count in 1950. Scrub Jays were seen on every Bradenton Christmas Bird Count from 1959 to 1976, with a maximum of 20 jays in 1964. No more than 6 jays were seen after the 1971 count. No counts were conducted from 1976 to 1981, and no jays were found when the Bradenton count was reinstituted in 1982.

Scrub Jays have been seen three times on the Breeding Bird Survey that begins at Fort Lonesome, Hillsborough Co. One jay was seen at stop 41 in 1972, one was seen at stop 30 in 1977, and one was seen at stop 29 in 1978. Stop 29 is on Duette Rd, 4.0-4.5 miles north of SR 64, stop 30 is 0.5 miles south of stop 29, and stop 41 is on SR 64, near the Hardee Co. line (see comments under Hardee Co.).

H. M. Stevenson (pers. comm.) found Scrub Jays in 1974 and 1977 on private property in northeastern Manatee Co., west of SR 39 and south of the Hillsborough Co. line.

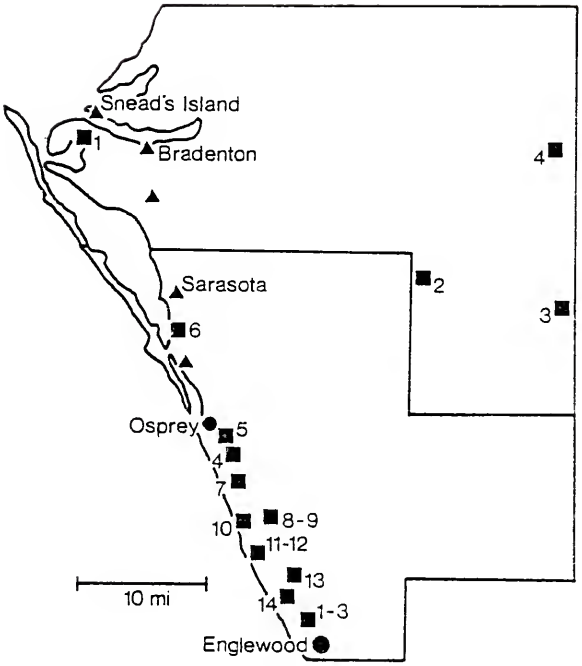

Figure 19. Locations of Scrub Jay records in Manatee (top) and Sarasota (bottom) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations; circles--other towns and cities.

Present. Scrub Jays are known from 4 locations in Manatee Co. At the site west of Myakka City (Manatee Co. 2), there is a substantial amount of scrub, and probably more than just the 2 jays I found there. The land is privately owned, and posted "For Sale." A small population (Manatee Co. 4) of jays is present on Duette Rd, about 3.0-3.5 miles north of SR 64, near stop 30 of the Fort Lonesome BBS. Another population is southeast of Myakka City, straddling the Manatee-DeSoto Co. line (Manatee Co. 3 and Desoto Co. 1).

I found no Scrub Jays in western Manatee Co., but have received one report of a very small population in Bradenton (Manatee Co. 1; D. D. Fulghum, in litt.). There are only a few remnants of scrub left in Bradenton, and I found no scrub at all on Snead's Island. Scrub Jays will probably disappear completely from western Manatee Co. in the next few years because of habitat destruction.

I was unable to investigate the site in northeastern Manatee Co. where H. M. Stevenson found Scrub Jays in the 1970's (see above), but there are patches of scrub scattered throughout eastern Manatee Co., and I would not be surprised if several of them supported small populations of Scrub Jay.

Marion County (excluding portions in Ocala National Forest) (Figure 20)

Historical. There is little information concerning the historical distribution of Scrub Jays in Marion Co. Two specimens were collected one mile east of Silver Springs in 1952, and single specimens were collected near Candler in 1964, and 8 miles west of Belleview in 1965. One egg set was collected at an unspecified location in 1911.

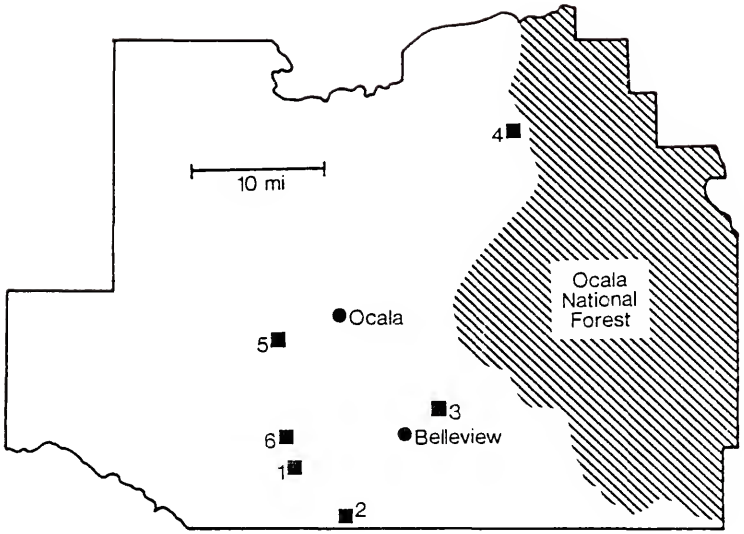

Figure 20. Locations of Scrub Jay records in Marion County, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); circles--other towns and cities. See Figure 21 for Ocala National Forest.

Westcott (1970) found Scrub Jays along C-484 where the highway bisects the "Big Scrub,"* 1-2 miles west of I-75.

Fossil remains of at least two Scrub Jays, dating from the late Pleistocene, have been found near Reddick (Hamon 1964).

Present. The "Big Scrub" is an extensive tract of scrub, 1-2 miles wide and about 12 miles long, extending from just south of the I-75 rest area south of Ocala to 3-4 miles south of the Sumter Co. line. Most of the Big Scrub is sand pine scrub, but there are some areas of oak scrub without sand pines, and those areas support Scrub Jays. The two areas where Scrub Jays were found in 1981 are in or near the two housing developments in the Big Scrub--Ocala Waterway development (Marion Co. 6) and Marion Oaks (Marion Co. 1).

The Ocala Waterway development has an extensive network of roads, but there were no houses in the Scrub Jay habitat as of July 1983. About 620 hectares (1550 acres) of scrub on the development and adjacent, undisturbed scrub were burned on 16 May 1977 (Mason M. Rowe, Forester, pers. comm.). This area is regenerating as dense 1-2 m oak

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* There is confusion in the literature over exactly what is meant by the "Big Scrub." The earliest use I have found of the term is in a soil survey of the Ocala area in 1915 (Mooney et al. 1915). The map illustrating the results of the survey was drawn in 1912, and shows a narrow strip of land running in a north-south direction, south of Ocala and west of Belleview, that is labelled "The Big Scrub." A few years later, Byrd (1927) found Scrub Jays abundant in "the Big Scrub in the eastern part of Marion Co." (p. 87), obviously referring to Ocala National Forest. Kurz (1942) and Laessle (1958, 1968) wrote as extensively on the scrub as anyone, and both of them called the scrub ridge west of Belleview "The Big Scrub." Various publications of the U. S. Forest Service (e.g., USDA Forest Service 1939; Cooper et al. 1959; Snedaker and Lugo 1972) state that Ocala National Forest is locally referred to as "The Big Scrub." I shall use the term only when referring to the scrub ridge west of Belleview.

scrub, with scattered 2 m sand pines. The road network provides most of the openings in the scrub and facilitated censusing of the area. I counted 40 Scrub Jays in an area of about 200 acres in February 1981. A more intensive census in 1982 yielded an estimate of 19.3 birds/40 ha. The census area appeared to have a higher density of jays than some of the surrounding area, so a reasonable estimate of the total Scrub Jay population in the entire burned area would be 250-300 birds.

Scrub Jays were also found at several places within the Marion Oaks development (Marion Co. 1). Marion Oaks is about 8 miles west of Belleview, in the vicinity of where the 1965 specimen was collected. Construction is proceeding rapidly at Marion Oaks. So far, all of the development is south of C-484, but the developers plan to extend the development to the north side of C-484. Scrub Jays may persist in scattered remnants of scrub at Marion Oaks, but most will surely disappear from that area in the next few years.

Undeveloped portions of the Big Scrub are worthy of preservation. An especially good area for Scrub Jays is the burned area adjacent to the Ocala Waterway development (Sec 26, T16S, R21E).

One other development in Marion Co. poses a direct and immediate threat to Scrub Jays--"Silver Springs Shores," just northwest of Candler (Marion Co. 3). Fifteen Scrub Jays were seen there in February and March, 1981, but most of the habitat will probably be cleared for houses within 10 or 20 years.

Scrub Jays were found at 3 other locations in Marion Co.--southwest of Belleview (Marion Co. 2), north of Eureka (4), and just west of Ocala (5). They are all fairly small populations, and do not seem to be in any immediate danger of destruction.

I found no Scrub Jays east of Silver Springs, but a few small patches of scrub remain in that area. However, the two specimens collected there were both juveniles, which could have just been wandering through the area.

Martin County (Figure 16)

Historical. Scrub Jays have been reported from Jonathan Dickinson State Park (Westcott 1970); 1-2 miles south of Port Salerno on SR A1A (Hundley 1964); Rio (Toussaint 1913); and a mile north of Stuart (Kuerzi 1939). Christy (1928) noted that Scrub Jays were frequently seen along the highway from Stuart south to Palm Beach.

Scrub Jay specimens have been collected at Stuart (2, 1913), Port Sewall (1, 1941), and Salerno (1, 1964).

Scrub Jays have been seen on every Christmas Bird Count conducted at Stuart since 1959, with a maximum of 42 in 1962. Thirty-five jays were seen on the 1974 count, 25 on the 1978 count, and 24 on the 1982 count, so the Christmas count data give little indication of a decline of Scrub Jay numbers in Martin Co.

Present. The major concentration of Scrub Jays in Martin Co. is at Jonathan Dickinson State Park (Martin Co. 1-6). I saw 98 Scrub Jays in the park in 1981, and estimate that the total population is over 200 birds. A wildfire burned over 400 hectares (1000 acres) of scrub in the park in 1971; that area is now excellent Scrub Jay habitat, with 2-3 m scrub oaks and sand pines, and much bare sand. To maintain the quality of the scrub here, portions of it should be burned on a rotational basis, beginning immediately, with a 5-10 year burn cycle on

each tract. Without fire, the density of Scrub Jays will begin to decline.

As development proceeds in Palm Beach Co., to the south of Jonathan Dickinson State Park, it is probable that the park will become the southernmost location for Scrub Jays on the Atlantic coast in a few years.

Scrub Jays are present at 5 sites between Stuart and Hobe Sound (Martin Co. 7-11). The site near Gomez (10) does not appear likely to be developed soon. The other sites are near Stuart (11) and Port Salerno. Two of those sites (7, 11) consist only of remnant scrub, and the other two (8 and 9) are in places where they could be developed anytime.

No Scrub Jays were found north of the St. Lucie River in Martin Co., even though some scrub remains. The disappearance of Scrub Jays from the area north of Stuart (including Rio), may be due to habitat destruction, or to natural succession of the scrub, rendering it unsuitable for Scrub Jays.

Ocala National Forest (portions of Lake, Marion, and Putnam Counties) (Figure 21)

Historical. Considering the abundance of Scrub Jays in the Ocala National Forest, there is remarkably little information concerning their historical occurrence there. Byrd (1927) wrote that Scrub Jays were abundant in the "Big Scrub" in eastern Marion Co., apparently referring to Ocala National Forest (see comments on the various uses of the term "Big Scrub" under Marion Co.). Howell (1932) listed Fort

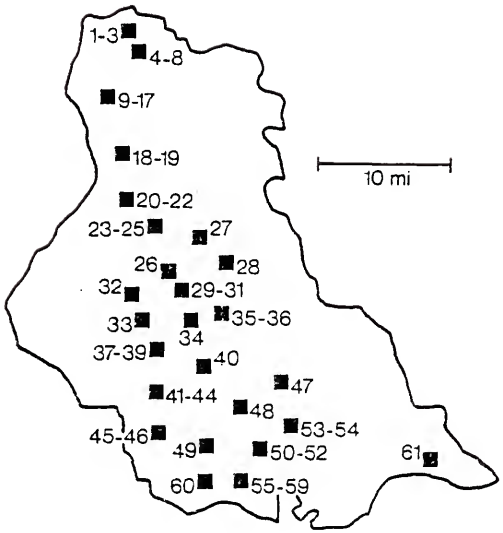

Figure 21. Locations of Scrub Jay populations in Ocala National Forest, 1980-1983 (numbers refer to list of sites in Appendix).

Gates as a locality for Scrub Jays. Brigham (1973) reported that Scrub Jays could be found along SR 19 through the Forest. Westcott (1970) found Scrub Jays at only a few sites in the Forest, and wrote that they were common only at the southern edge of the Forest. He considered most of the oak scrub without sand pines too dense to support many Scrub Jays.

A. H. Howell saw several Scrub Jays in the Ocala National Forest in March, 1938 (Biol. Surv. files).

Scrub Jay specimens are from one mile east of Alexander Springs (1, 1947), 2 miles west of Astor Park (1, 1947), and Fullerville (2, 1957), all in the southeastern portion of the Forest; and Fort Gates, on Lake George (2, 1876-1877).

Present. I found Scrub Jays at 61 sites in Ocala National Forest in 1981 and 1982. Sites 1-36 (Appendix) are in the Lake George Ranger District, north of SR 40; sites 37-61 are in the Seminole Ranger District, south of SR 40. The Scrub Jay populations were scattered throughout the scrub portions of the Forest, but were concentrated in three general areas: along FR 97, FR 75, and FR 31, north of C-316; along FR 79, between SR 40 and FR 73; and along FR 66, between FR 73 and FR 87. I investigated sites only along improved roads in the Forest; there are doubtless many more Scrub Jays in less accessible portions of the Forest.

Of the 61 sites in which I found Scrub Jays, 57 were in stands of sand pines that were clearcut between 1965 and 1980. None were in stands of mature sand pine. Scrub oaks and palmettoes regenerate quickly from underground roots following clearing or burning, and the

oaks may be up to 2 m tall after 5 years. Sand pines, on the other hand, can regenerate only from seeds, so regeneration takes longer. Sand pines less than 2-4 m tall, or with canopy cover <50%, do not seem to affect the density of Scrub Jays on a given site. However, dense stands of sand pine greater than 3-4 m tall do not provide suitable Scrub Jay habitat. That stage in regeneration usually begins 10-15 years after clearing. Therefore, because of the relatively rapid regeneration of scrub oaks, and the relatively slow regrowth of sand pines, clear-cuts provide suitable Scrub Jay habitat from about 5 years (minimum of 3 years) after cutting, until 10-15 years after cutting, when the sand pines form a dense, closed canopy. Most scrub in Ocala National Forest is thus suitable for Scrub Jays for a maximum of 10-12 years. In 1981-82, over half of the stands regenerated from 1975 to 1978 were occupied by Scrub Jays (Table 5), evidence that stands 4-7 years old provide the best Scrub Jay habitat in the Forest.

Once the scrub becomes too old and dense, Scrub Jays must move on to colonize another, more recently cleared site. Thus, the Forest presents an ever-changing mosaic of habitat suitable for jays. I predict that 10 years from now, few, if any, Scrub Jays will still be present at the sites where I found jays in 1981 and 1982, but that jays will be present in many other sites.

Habitat use by Scrub Jays in Ocala National Forest is discussed further in Chapters 3 and 4.

I estimated the total population (P) of Scrub Jays in Ocala National Forest with the following equation: $P = \sum A_i p_i N_i$, where A_i = the total area of all stands in the ith age class, p_i =

Table 5. Figures used to estimate total number of Florida Scrub Jays at Ocala National Forest, Florida.

A. Assuming each stand with Scrub Jays has a population density of jays equal to that of the census area with the lowest population density (14.3 jays/40 ha)

Age (Year reseeded)	Estimated Density (jays/40 ha)	Area (ha)	Proportion of stands inhabited by Scrub Jays
1979-81	14.3	7200	0.040
1978	14.3	2400	0.529
1977	14.3	2280	0.667
1976	14.3	1380	0.364
1975	14.3	1380	0.722
1974	14.3	1380	0.143
1973	14.3	1380	0.333
1972	14.3	1380	0.286
1971	14.3	1380	0.375
1970	14.3	1380	0.143
1969	14.3	1380	0.200
1968	14.3	1380	0.000
1967	14.3	1380	0.250
1966	14.3	1380	0.000
1965	14.3	1380	0.250

Total population = 2613 Scrub Jays

Table 5, continued.

B. Assuming each stand with Scrub Jays has a population density of jays equal to that of the census area nearest it in age.

Age (Year reseeded)	Estimated Density (jays/40 ha)	Area (ha)	Proportion of stands inhabited by Scrub Jays
1979-81	14.3	7200	0.040
1978	14.3	2400	0.529
1977	14.3	2280	0.667
1976	21.8	1380	0.364
1975	21.8	1380	0.722
1974	17.9	1380	0.143
1973	17.9	1380	0.333
1972	23.6	1380	0.286
1971	23.6	1380	0.375
1970	23.6	1380	0.143
1969	23.6	1380	0.200
1968	23.6	1380	0.000
1967	23.6	1380	0.250
1966	23.6	1380	0.000
1965	23.6	1380	0.250

Total population = 3436 Scrub Jays

the proportion of the area in a given age class supporting Scrub Jays, and N_i = the population density of Scrub Jays in stands of that age class. The total areas of all stands in each age class were obtained from the offices of the Seminole and Lake George Ranger Districts, Ocala National Forest. For each age class, the proportion of the area inhabited by Scrub Jays was assumed to be equal to the proportion of stands in that age class inhabited by Scrub Jays (which assumes, in turn, that stands with and without Scrub Jays are of the same average sizes). I used two different sets of figures for the population densities of Scrub Jays in each age class: 1) to obtain minimum estimates, I assumed that all stands with Scrub Jays had a density of 14.3 birds/40 ha, the lowest density I found on my four study areas in the Forest (see Chapter 3); 2) to obtain higher estimates, I assumed that each stand had a Scrub Jay density equal to that of the census area nearest it in age. I thus obtained estimates ranging from 2613-3436 Scrub Jays in Ocala National Forest (Table 5). In the past few years, the Forest Service has increased the acreage of sand pines harvested each year, so the total population of Scrub Jays in Ocala National Forest may increase somewhat in the next few years.

Prior to the establishment of Ocala National Forest, and even into the 1920's and 1930's, wildfires created natural openings in the sand pine scrub. Some of the fires burned several hundred or even thousand acres at a time, and Scrub Jays would have occupied the regenerating, burned-over areas. Fires are now suppressed in the Forest, but clear-cuts provide the same sort of environment for Scrub Jays. As long as current management practices are continued, the future of jays in the Forest seems secure.

Okeechobee County (Figure 14)

Historical. Sprunt (1946, 1954, 1958) and Mayr and Greenway (1962) wrote that Scrub Jays were absent from the Kissimmee Prairie, which covers much of Okeechobee Co. One egg set was collected at Basinger in 1928. W. Hoxie (Biol. Surv. files) reported that Scrub Jays were very rare around Fort Drum, August-November 1888.

Present. I found Scrub Jays at one site near Basinger (Okeechobee Co. 1). There seemed to be little scrub in the area.

There is quite a bit of scrub around Fort Drum, but I have received only one report of Scrub Jays there--one bird seen 20 March 1982 (M. Allen, in litt.). Whether the bird was a vagrant or a local resident is moot.

Orange County (Figure 22)

Historical. Scrub Jays have been reported in the literature from Orlando (Howell 1932); northwest of Orlando (Schroder, in Sprunt 1946); and Zellwood (Howell 1932). D. J. Nicholson (in Sprunt 1954) reported a marked diminution in numbers of Scrub Jays in the Orlando area due to environmental changes. Scrub Jays were reported on every Orlando Christmas Bird Count from 1967 to 1981, with highs of 18 in 1970 and 9 in 1977. No Scrub Jays were seen on the 1982 Orlando Christmas count.

Scrub Jay specimens have been collected at Bay Ridge (1, 1957), Orlando (1, 1953), 7 miles east of Orlando (1, 1945), 10-15 miles southwest of Orlando (19, 1934-1946), and unspecified Orange Co. locations (2, 1957). Egg sets were collected near Orlando (1,

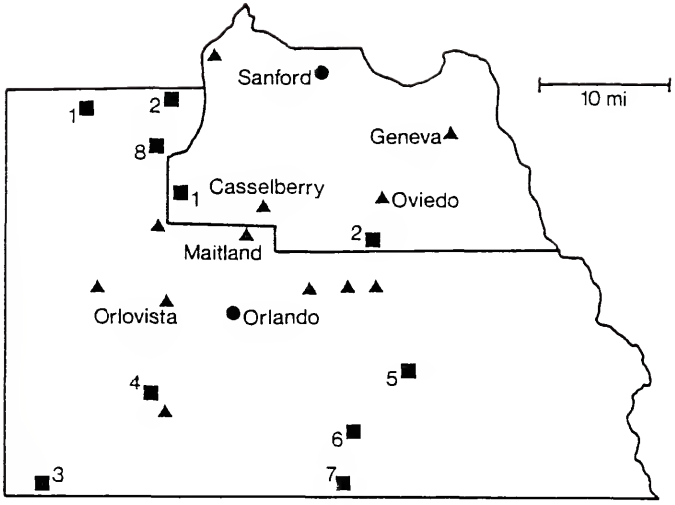

Figure 22. Locations of Scrub Jay records in Orange (bottom) and Seminole (top) Counties, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations; circles--other towns and cities.

1950), 5-6 miles west of Orlando (5, 1915-1922), 8-9 miles west of Orlando (4, 1922-1930), 8.5-9 miles northwest of Orlando (2, 1922 and 1930), 2-3.5 miles east of Orlando (4, 1923-1928), 10-12 miles east of Orlando (4, 1957-1960), Maitland (1, 1957), near Lockhart (1, 1929), 1.5-3 miles northwest of Lockhart (10, 1922-1925), and 1/2 and 2 miles north of Vineland (2, 1960 and 1963). An Orange Co. road map from the 1920's shows Lockhart about 1 1/2 miles east of what is now the junction of I-4 and the I-4-Beeline Connector (SW 1/4 Sec 6, T24S, R29E), not at its present location about 6 miles northwest of Orlando. The locations northwest of Lockhart and north of Vineland are in the same general area as the ones 10-15 miles southwest of Orlando, so totals of 19 specimens and 13 egg sets are known from that area.

Concerning an area 10 miles east of Orlando on SR 50, D. J. Nicholson (unpublished field notes, 5 April 1960) wrote that the site was then being cleared for houses, and that the site represented "the last known breeding grounds of these jays in all of Orange County!" Nicholson was clearly wrong about the site being the last place with Scrub Jays in Orange Co. (see below), but his comments indicate the problems faced by Scrub Jays in the county, and in Florida in general.

Present. No Scrub Jays remain east of Orlando. Although there is still some scrub in that area, most of it is sand pine scrub, and unsuitable for Scrub Jays. The locations which in the 1920's were 5-8 miles west of Orlando are near the town of Orlovista, now only one mile west of Orlando; I found no scrub at all in that area, or at Maitland.

Only one family of Scrub Jays was found southwest of Orlando (Orange Co. 4); that site is about 3 miles northwest of the former location of Lockhart. The Orange Co. Soil Survey (Soil Conservation Service 1960) shows that a tract of scrub about 12 miles long (north-south) and 2-3 miles wide (east-west) was once present in that area, centered on Big Sand Lake. Nearly all of the natural vegetation in that tract has been cleared for houses or citrus groves.

The largest population of Scrub Jays in Orange Co. is in the Rock Springs Run State Reserve (Orange Co. 2), just to the northeast of Wekiwa Springs State Park. Twelve Scrub Jays were found there in March 1981, and 19 in July 1983. Scattered patches of oak scrub, and a large tract of sand pine scrub, are located in the north-central part of the reserve. I estimate the total population of Scrub Jays in the reserve to be 40-50 birds.

A fairly large population of Scrub Jays is present about 5 miles southeast of Orlando (Orange Co. 5), but some of the scrub is scheduled to be cleared for a power plant, beginning in 1983.

Small numbers of Scrub Jays can be found at an additional 5 sites (Orange Co. 1, 3, 6, 7, 8) in Orange Co. Only the jays at Wekiwa Springs State Park (7) and on the Walt Disney World property (3) are protected, and there may not be more than 2 or 3 families of jays at each of those locations.

Howell's (1932) Zellwood location is probably referrable to the Bay Ridge site (Orange Co. 1). Some of the scrub there has been cleared for houses.

Osceola County (Figure 23)

Historical. Sprunt (1946, 1954, 1958) and Mayr and Greenway (1962) reported that Scrub Jays were absent from the Kissimmee Prairie, which covers much of Osceola Co. One Scrub Jay, however, was found dead on US 441 about 2 miles south of Yeehaw Junction in 1974 (Taylor 1982), and three jays were seen in the same area in 1982 (Paul 1982).

Present. A small population of Scrub Jays inhabits scrub along US 441, about 2 miles south of Yeehaw Junction (Osceola Co. 2). Yeehaw Junction is in the middle of the Kissimmee Prairie. Another small, isolated population is present in the southwest corner of Osceola Co. (Osceola Co. 1).

There are numerous patches of oak scrub in the vicinity of Kissimmee and Saint Cloud, but apparently none of them support Scrub Jays (pers. obs.; Westcott 1970).

Palm Beach County (Figure 4)

Historical. Although Bryant (1859) saw no Scrub Jays south of Jupiter, and Bendire (1895) reported that Scrub Jays were not to be seen south of Lake Worth, Christy (1928) reported that Scrub Jays were frequent along the highway from Stuart, Martin Co., to about 25 miles south of Palm Beach, which would be near the Broward Co. line. Also, Eastman (1950) wrote that Scrub Jays were present in the scrub west of Delray, and north and south for several miles. Howell (1932) listed Lake Worth, Jupiter, and West Palm Beach as locations of Scrub Jay populations. Three Scrub Jays were reported at Delray in 1924 by Holt and Sutton (1926).

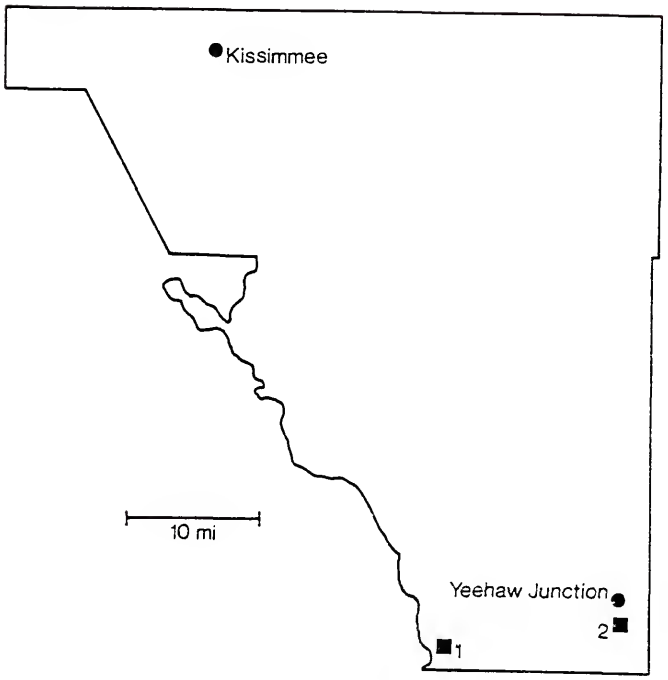

Figure 23. Locations of Scrub Jay records in Osceola County, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); circles--other towns and cities.

Scrub Jays have been seen on every Christmas Bird Count at West Palm Beach since 1959. The maximum number recorded was 40 jays in 1972; no more than 15 have been seen on any count since then.

Palm Beach Co. Scrub Jay specimens are from Delray (1, 1924); Jupiter (25, 1896-1921); Lake Worth (8, 1889-1920); Lantana (1, 1896); and Palm Beach and West Palm Beach (8, 1900-1948; and one, undated); and unspecified locations (4, 1921-1923). There are 4 egg sets from near Lantana in 1894, 2 from near Boynton in 1905, and one collected "on road to Palm Beach" in 1922.

Single Scrub Jays were seen in Boca Raton on Breeding Bird Surveys in 1968 and 1973.

Several pairs of Scrub Jays were seen at Juno and "in the pines opposite Hypoluxo" in 1889 by M. M. Green (Biol. Surv. files). J. J. Ryman (Biol. Surv. files, 1913) reported that Scrub Jays were common 10 miles north of West Palm Beach (= near Juno Beach). A. H. Howell (Biol. Surv. files, 1918) found Scrub Jays to be numerous "in the thick scrub just back of the beach" at Jupiter.

C. H. Plockelman (in litt.) has reported that Scrub Jays were formerly present between Lake Worth and PGA Blvd in North Palm Beach, but states that the area was extensively developed in the 1970's, and jays are no longer present.

Present. Scrub Jays at one time were widespread in eastern Palm Beach Co.; they were probably almost continuously distributed along the Atlantic coastal ridge scrub.

Scrub Jays were found at 15 places in Palm Beach Co. in 1980-81. The sites are clustered in the Boynton Beach-Delray Beach area (Palm

Beach Co. 1-8) and in the Jupiter-Juno Beach area (9-15). No Scrub Jays remain in the Palm Beach-West Palm Beach area, due to habitat destruction.

Most or all of the sites where Scrub Jays are still present will probably be developed in a few years. The only site large enough to be suitable for preservation is Palm Beach Co. 14, along US 1 between Jupiter and Juno Beach, and portions of that scrub have already been cleared. I suspect that it will be difficult to find a Scrub Jay in Palm Beach Co. in 15 years.

Panhandle Gulf Coast

Scrub Jays have never been recorded from the Florida Panhandle, but extensive areas of coastal scrub are present along the coastal portions of the Panhandle. I visited some of those areas to determine if there were any obvious reasons for the absence of Scrub Jays from them.

In undisturbed areas, coastal scrub exists in a narrow belt directly behind the coastal dunes. The scrub is extremely dense, and the only natural openings are along the dune border. The scrub appears very similar to that along the Atlantic barrier islands, especially in Flagler and Volusia Counties. I suspect that Scrub Jays could live in some areas along the Gulf Coast in the Panhandle, but at relatively low densities, comparable to those on the Atlantic barrier islands (see Chapter 3).

At some time in the past, probably when sea levels were much lower than at present, Scrub Jays presumably were continuously distributed

from Texas to Florida, in areas that are now under water (Pitelka 1951). As the sea level rose, scrub habitat and Scrub Jays were squeezed into smaller and smaller areas. Eventually, Scrub Jays would have become restricted to the present day range of scrub in the Panhandle. Without nearby sources of immigrant jays, the population densities may have been too low to permit indefinite survival of Scrub Jay populations in the Panhandle, and they became locally extinct.

Pasco County (Figure 15)

Historical. New Port Richey has been mentioned as a locality for Scrub Jays by several authorities (Preetorius 1928; DuMont 1931; C. E. Doe, unpublished field notes, 1931-1934; Sprunt 1946; Dennis 1950).

Five Scrub Jays were counted within a 40-mile diameter circle on the Zephyrhills Summer Bird Count in 1969 (Stevenson 1970a). Fourteen jays were seen on the New Port Richey Christmas Bird Count in 1979, one in 1980, 13 in 1981, and one in 1982.

There are 2 Scrub Jay specimens from Anclote in 1897, and one from New Port Richey in 1946, and one from an unspecified Pasco Co. location in 1916.

Present. No Scrub Jays were found in New Port Richey. They were probably extirpated by development. A small population at Hudson (Pasco Co. 1) will probably also be gone in a few years, as the development there appears to be growing rapidly.

An isolated population of Scrub Jays inhabits a patch of scrub about 7 miles west of San Antonio (Pasco Co. 2). There may well be

other small populations in that area. If so, they represent the only possibility of Scrub Jays persisting in Pasco Co.

Pinellas County (Figure 24)

Historical. Published locations of Scrub Jays in Pinellas Co. include Dunedin (Howell 1932); near Gandy Bridge (Fargo 1926); Indian Rocks (Fargo 1926; DuMont 1931; Pangburn 1935); and Tarpon Springs (Howell 1932). Specimens are from Belleair (1, 1889), Clearwater (9, 1880-1907), Dunedin (2, 1905), Indian Rocks (4, 1926-27), Johns Pass (1, 1918), Sand Key (1, undated), and Tarpon Springs (11, 1890-1894). C. E. Doe collected 7 Scrub Jay egg sets south of Ulmerton, 1928-1931, and his field notes reveal that he found Scrub Jays near a church in Anona, 1929-31.

Scrub Jays were found in May, 1916, at Turtle Crawl Point, near Johns Pass (A. H. Howell, Biol. Surv. files).

Two Scrub Jays were seen on the St. Petersburg-Gulfport Christmas Bird Count in 1932. One jay seen on the 1962 Christmas count was considered unusual. No other Scrub Jays have been reported on Pinellas Co. Christmas counts, even though counts have been made almost every year since 1928 at St. Petersburg or Gulfport.

A single Scrub Jay on Weedon Island in 1976 was said to be the first one in the St. Petersburg area since 1962 (Edscorn 1977).

There is a report that a population of Scrub Jays on Weedon Island was wiped out in the 1950's by the proprietor of a roadside zoo, who killed all the birds and fed the carcasses to his captive animals (C. W. Biggs, pers. comm.).

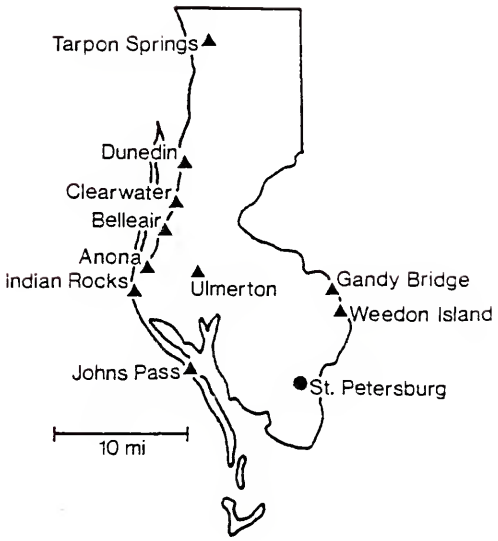

Figure 24. Locations of Scrub Jay records in Pinellas County, Florida. Triangles--former Scrub Jay populations; circle--other city.

Present. Scrub Jays were widely distributed in coastal Pinellas Co. until at least the 1930's. They were competely gone from the St. Petersburg area by about 1960. I have no information on when Scrub Jays were last present near Clearwater or Tarpon Springs. The extirpation of Scrub Jays from Pinellas Co. is clearly due to habitat destruction. Very little oak scrub remains in the county.

Weedon Island is now state property, and some habitat suitable for Scrub Jays remains on it. The island should be considered a potential site for reintroduction of jays, should that step ever be considered desirable.

Polk County (Figure 25)

Historical. Except for Christmas Bird Count records, the only location for Scrub Jays in Polk Co. that I have been able to find in the literature is along the road to Lake Arbuckle Boat Landing, southeast of Lake Reedy near Frostproof (Hundley 1964; Steffee and Mason 1971a).

Scrub Jays have been seen on all but one Lake Wales Christmas Bird Count since 1971. A maximum of 35 Scrub Jays was reported in 1982.

I have not located any Scrub Jay specimens or egg sets from Polk Co.

Present. I saw a minimum of 103 adult Scrub Jays in Polk Co. in 1981. The Scrub Jay populations are scattered throughout the eastern half of the county. Areas with the largest numbers are Avon Park Bombing Range (Polk Co. 1-3); on Lake Arbuckle Road (7); Indian Lake Estates (12); Lake Kissimmee State Park (13, 14); and along Boy Scout

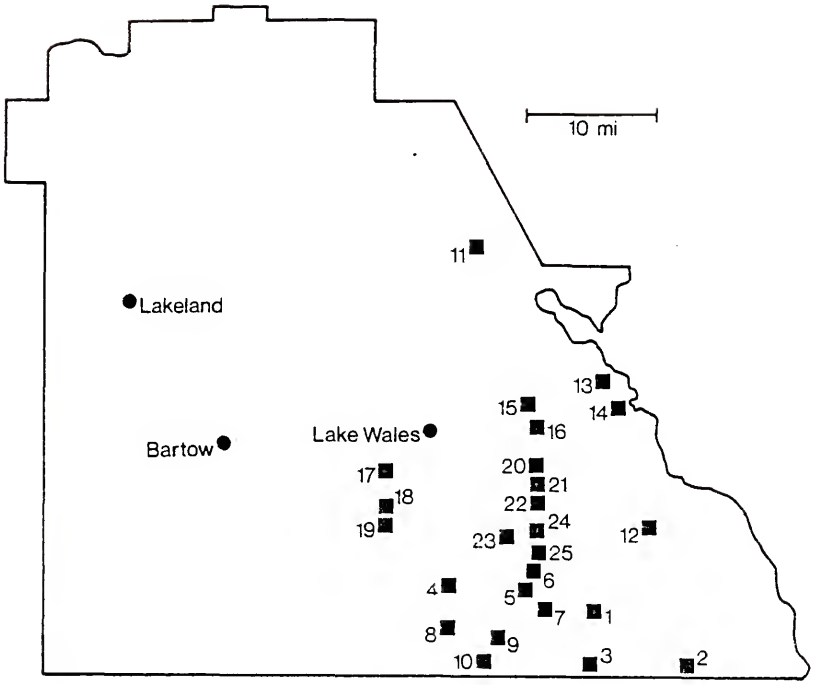

Figure 25. Locations of Scrub Jay populations in Polk County, Florida, 1980-1983 (numbers refer to list of sites in Appendix); circles--other towns and cities.

Camp Road and Lake Walk-In-The-Water Road (16, 20-22, 24-25). The populations in the state park and on the bombing range are secure. Scrub Jays nest on or near Tiger Creek Nature Preserve (22, 23), and are protected there. An employee at Indian Lake Estates indicated that that development is growing quite slowly--only about 10 new houses a year--but that situation could change at any time. Some development is taking place along Lake Walk-In-The-Water Road and Boy Scout Camp Road, but the jays on the scout camp itself are protected.

I saw no indications of development along Lake Arbuckle Road (Polk Co. 7). Aerial photographs taken in 1979 show scrub covering about 300 hectares (750 acres) in that area. With its mosaic of oak scrub and grassy ponds, and scattered slash pines, the area bears a certain resemblance to the scrub at Archbold Biological Station. Assuming a population density of 10 birds/40 ha--roughly the density at Archbold Biological Station--the area may support as many as 75 Scrub Jays. The site is certainly worthy of preservation.

The remaining Scrub Jay sites are mostly small and widely scattered. Some of them will no doubt be developed soon.

Putnam County (excluding portions in Ocala National Forest) (Figure 12)

Historical. Howell (1932) listed Palatka as a locality for Scrub Jays. There is one 1974 specimen from Putnam Hall.

Harper (1942) concluded that the type locality of the Scrub Jay, based on William Bartram's Travels, was a scrub 13 miles southwest of Palatka, between Rodman and Deep Creek.

M. Mullis (pers. comm.) has told me that Scrub Jays were common just west of Putnam Hall on SR 26 until about 1975, when most of the habitat was cleared.

Present. At least one pair of Scrub Jays still inhabits the scrub west of Putnam Hall on SR 26 (Putnam Co. 3; see above).

There are at least two other small populations of Scrub Jays in northwestern Putnam Co.: northeast of Florahome (Putnam Co. 1); and just north of Grandin (2). Some of the scrub at the Florahome and Putnam Hall locations has been cleared in the past few years; the Grandin site appears undisturbed.

No scrub or Scrub Jays were found near Palatka.

Some scrub is still present in the vicinity of the purported type locality, between Rodman and Deep Creek, but none of it appears suitable for Scrub Jays, and I found none there.

St. Johns County (Figure 7)

Historical. Scrub Jays in St. Johns Co. have been reported from Anastasia Island (Pitelka 1951); Crescent Beach (Lane 1981); Pellicer's Creek (Howell 1932); Ponte Vedra Beach (Grimes 1940); St. Augustine (Ord 1818; Bryant 1859; Howell 1932); and south of St. Augustine (Bendire 1895; Sprunt 1946).

From 2 to 8 Scrub Jays were counted on St. Augustine Christmas Bird Counts between 1946 and 1949. No Christmas counts were conducted in the county from 1950-1973. No jays have been seen on the St. Augustine count since it was reinstituted in 1974.

There are 6 Scrub Jay specimens and one egg set from Pellicer's Creek in 1894, 2 undated St. Augustine specimens, 2 specimens from 10 miles north of St. Augustine in 1937, and one egg set from North Beach (north of St. Augustine Inlet) in 1933.

At one time, Scrub Jays were common along nearly the whole length of the barrier island in St. Johns Co. (S. A. Grimes, in litt.). A pair of Scrub Jays nested at Mineral City (now Ponte Vedra Beach) in 1931 (Grimes 1932), but by 1940, Grimes (in Sprunt 1946) was "no longer able to find a single jay in . . . northern St. Johns County," as the scrub had been cleared for development. About 1930, Scrub Jays were present just east of US 1, about 1-1/2 miles south of the St. Augustine Airport (Grimes, in litt.).

Sprunt (1946) felt that St. Augustine marked the northen limit of the range of the Scrub Jay. Less than 25 years later, however, the northern limit had retreated 15 miles south to Marineland, at the northern edge of Flagler Co. (Stevenson 1970b).

Single Scrub Jays, apparently vagrants, were seen at Ponte Vedra Beach in 1973 (Kale 1973) and near Mickler Landing in 1976 (S. A. Grimes, in litt.).

Present. Scrub Jays have been extirpated from St. Johns Co. There is some scrub left in the county, especially on the barrier island north of Vilano Beach. Long stretches of that scrub are relatively undisturbed, and appear as though they would provide adequate Scrub Jay habitat. It is not clear why Scrub Jays have disappeared from this area. S. A. Grimes (in litt.) thinks that some of the jays may have been shot. He has seen several people with guns

in the area, and a tame Scrub Jay would present a tempting target to certain people. Scrub Jays frequently forage along roadsides, and some birds have doubtless been killed by passing cars and trucks. Since the scrub forms a long, narrow strip along the barrier island in St. Johns Co., and since SR A1A runs right down the middle of it, there would have been the potential for several birds to be killed in that manner. A third possibility is that the habitat has become less suitable for Scrub Jays than it once was, even though it looks suitable to me. I do not know if fires were ever very common in coastal scrub, but the scrub in St. Johns Co. is extremely dense, with few natural openings, as would be expected in the absence of fire. Probably all three factors played roles in the disappearance of Scrub Jays from St. Johns Co. This matter is discussed further in Chapter 3.

Even in the absence of Scrub Jays, the scrub north of St. Augustine should be preserved as a good example of dune scrub. If preserved, the area would provide a potential site for the reintroduction of Scrub Jays into St. Johns Co.

St. Lucie County (Figure 16)

Historical. Schroder (1923) reported 4 Scrub Jays near St. Lucie in 1919, and Kuerzi (1939) reported a few pairs of jays between Fort Pierce and Vero Beach. Scrub Jays have been found on most Christmas Bird Counts at Fort Pierce since 1957, with a maximum of 13 in 1966. There are no specimens or egg sets from the county.

H. W. Kale II (pers. comm.) reported that a former population of Scrub Jays near Searstown in Fort Pierce was wiped out by development.

Present. Scrub Jays were found in two general areas in St. Lucie Co. in 1981: near the St. Lucie County Airport, just north of Fort Pierce (St. Lucie Co. 1-3); and along the FEC Railway tracks south of Fort Pierce (4, 5). The population near the airport will likely be wiped out by development within a few years. Some of the land along the railroad is already contained within The Savannahs State Preserve, and development of the privately owned portions does not seem imminent. The total population of Scrub Jays along the railroad may consist of 20-30 birds, and it can be expected to survive indefinitely.

Sarasota County (Figure 19)

Historical. Scrub Jays have been reported in Sarasota Co. from near Englewood (Smith 1940; Sprunt 1946); Myakka (Pitelka 1951); Oscar Scherer State Park (Hundley 1964; Lane 1981); Sarasota (Howell 1932); and Venice (Howell 1932). Byrd (1927) wrote that Scrub Jays had been fairly abundant in Sarasota Co. in 1924, but clearing of much of the scrub in 1925 caused the population size to decline.

Scrub Jays have been seen regularly on Sarasota Christmas Bird Counts since 1931. The maximum number recorded was 33 in 1976, but no more than 10 have been counted in any year since then. The Venice-Englewood Christmas count has recorded Scrub Jays every year since its inception in 1973, with a maximum of 56 in 1979. A Christmas Bird Count has been conducted at Myakka River State Park in all but 6 years since 1946, but Scrub Jays have been recorded in only two years: 2 were seen in 1967, and 4 in 1975. The state park Christmas count covers some of Manatee Co., and includes one site in Manatee Co. known to have Scrub Jays (Manatee Co. 2).

Scrub Jay specimens have been collected at Sarasota (1, 1898), 4 miles south of Sarasota (1, 1934), 6 miles south of Sarasota (1, 1945), and Osprey (2, 1920). Three egg sets have been collected, one at Osprey (1931) and two at Sarasota (1888 and 1904).

N. B. Moore (Biol. Surv. files) found a Scrub Jay nest at Sarasota Bay in 1872. A. H. Howell (Biol. Surv. files) saw several Scrub Jays in oak scrub along the road between Sarasota and Venice in 1925. Howell (Biol. Surv. files) also saw Scrub Jays near Englewood in 1938.

B. Mink (pers. comm.) states that Scrub Jays are much less common in the Englewood area than they used to be, due to habitat destruction.

Present. Scrub Jays are present at 14 locations in Sarasota Co. All of the locations are within 3 or 4 miles of the Gulf Coast. Scrub Jays have evidently declined significantly in the Sarasota area, as indicated by my finding only one jay in the city in 1981 (Sarasota Co. 6). Little scrub is left in the vicinity of Sarasota. I found no jays between Sarasota and Oscar Scherer State Park.

With the exception of Oscar Scherer State Park (Sarasota Co. 4), all of the Scrub Jay populations in the county are in locations likely to be developed sometime in the future. Private property (Sarasota Co. 5) adjacent to Oscar Scherer State Park deserves protection, and would make an excellent addition to the park. None of the other sites in the county are large enough to make their protection worthwhile. Because of development, it is possible that Oscar Scherer State Park will support the only population of Scrub Jays on the southwest Florida Gulf coast in 20 years. Therefore, it is particularly important that as much of the scrub around the park be preserved as possible.

I found no Scrub Jays in Sarasota Co. near Myakka, but there is a small population near there in Manatee Co. (Manatee Co. 2).

Seminole County (Figure 22)

Historical. Mason (1937) wrote that Scrub Jays were uncommon residents in the southwestern part of the county. On Seminole Co. Summer Bird Counts, one Scrub Jay was seen in 1967 (Stevenson 1968), and 2 in 1968 (Stevenson 1969). Between 12 and 19 jays were found on Sanford Christmas Bird Counts from 1966 to 1970. The Christmas count area included portions of southwestern Volusia Co. where Scrub Jays are resident.

There are 2 Scrub Jay specimens from Geneva in 1896, and 2 egg sets from 2 miles east of Oviedo in 1957.

K. Morgan (in litt.) saw Scrub Jays regularly from 1977-1979 on Wekiva Park Drive north of SR 46, near the Wekiva River. G. Bretz (pers. comm.) reported Scrub Jays behind the Sun Bank in Casselberry in 1980.

W. K. Taylor (in litt.) was unable to find any Scrub Jays near Geneva or Oviedo in winter, 1982-83.

Present. I know of only 2 places where Scrub Jays can be found in Seminole Co.: in Altamonte Springs, near the Orange Co. line (Seminole Co. 1); and at a previously unreported location south of Oviedo (2). Both populations are in areas being developed.

No jays were found at any of the other previously reported locations, although some scrub is still present at all of them. Some clearing has taken place at most of those locations, but with the

exception of Casselberry, probably not enough to acount for the almost total absence of Scrub Jays from the county. Natural succession, making the habitats unsuitable for Scrub Jays, may be partially responsible.

Sumter County (Figure 6)

Historical. Howell (1932) listed Lake Panasoffkee as a locality for Scrub Jays.

There are 11 Scrub Jay specimens from Sumter Co., all collected at "Scrub Pond," 1932-1933. I have been unable to determine the location of Scrub Pond.

Scrub Jays have been seen fairly regularly at stops 11, 12, 21, and 22 on the Mabel Breeding Bird Survey. Stops 11 and 12 are on SR 469, approximately 1/4 mile and 3/4 mile, respectively, north of Tuscanooga Rd. Stops 21 and 22 are on SR 48, within one mile of the Lake Co. line.

Two Scrub Jays were seen by W. H. Ball in scrub on the Withlacoochee River near Lake Panasoffkee in 1929 (Biol. Surv. files).

Scrub Jays were present until about 1978 along I-75 northwest of Coleman (R. W. Repenning, pers. comm.), but most of that scrub has been cleared.

Present. I have found Scrub Jays at 5 locations in Sumter Co. None of the populations are in typical scrub. A single jay is seen regularly along I-75 northwest of Wildwood (Sumter Co. 4). No more than one jay has ever been seen there, and the jay, when seen, is always perched on power lines above a big clump of palmettoes, with

pasture all around. The other jays in Sumter Co. are in hardly more likely places, but they are in places with at least a few oaks and an open canopy, which are among the most basic requirements of Scrub Jays (see Chapter 3).

The population northeast of Center Hill (Sumter Co. 1), and one of the populations south of Center Hill (2), are in areas where Scrub Jays have been seen on the Mabel Breeding Bird Survey. At those spots, plus the other site south of Center Hill (3), Scrub Jays inhabit a few oaks beside the road, surrounded by unsuitable habitat (pasture, pine plantation, citrus groves). The presence of Scrub Jays in such atypical habitats gives one some optimism concerning the ability of Scrub Jays to survive in future Florida environments.

Volusia County (Figure 26)

Historical. Scrub Jays have been reported in Volusia Co. from Blue Springs (Allen 1871; Maynard 1881; Howell 1932); Coronado (Longstreet 1912); Daytona Beach (Bendire 1895; Howell 1932; Dennis 1950); Enterprise (Bryant 1859; Jackson 1887; Litch 1928; Howell 1932; Longstreet 1954; Ackerman 1958; Hundley 1964; Steffee and Mason 1971a); New Smyrna (Taylor 1862); Oak Hill (Longstreet 1937); Orange City (Howell 1932); and Ormond Beach (Longstreet 1937; Sprunt 1946). Longstreet (1954) wrote that Scrub Jays had been common near New Smyrna Beach, but "the inroads of the restless realtors have driven the birds away, via bull-dozers and cottages. One can now ride for miles back of the dunes and see no Scrub Jays" (p. 85).

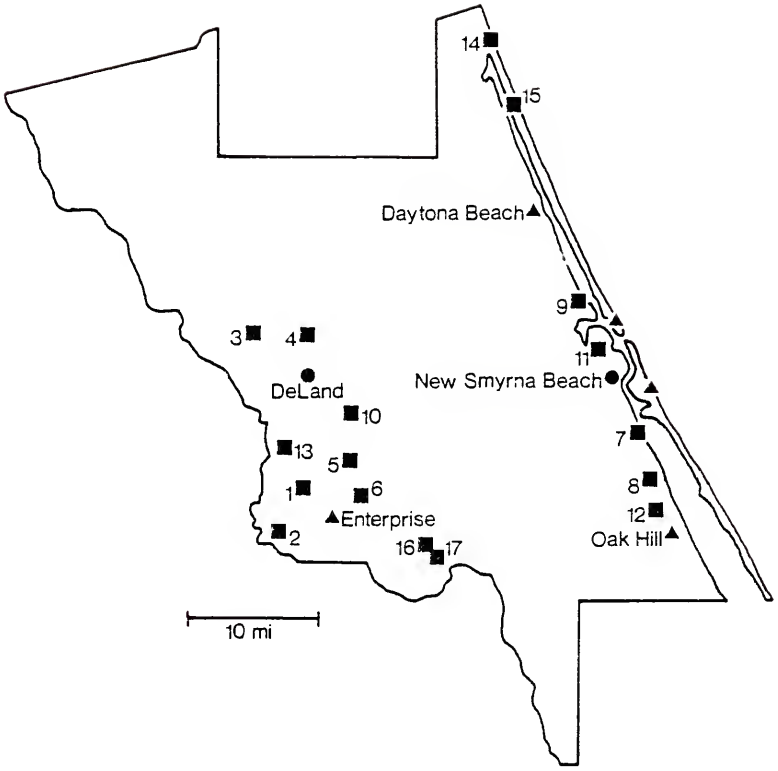

Figure 26. Locations of Scrub Jay records in Volusia County, Florida. Squares--locations of Scrub Jay populations, 1980-1983 (numbers refer to list of sites in Appendix); triangles--former Scrub Jay populations; circles--other towns and cities.

At least 56 specimens and 15 egg sets of Scrub Jays have been collected in Volusia Co. The specimens are from Blake (2, 1885); Blue Springs (24, 1869-1907); DeBary (1, 1963); DeLand (2, 1921); Enterprise (23, 1869-1902); Orange City (2, 1907 and 1951); Ponce Park (1, 1925); and Smyrna (1, 1902). The egg sets are from Blue Springs (1, 1957); Daytona (1, 1891); near DeBary (4, 1957-1965); near Enterprise (1, 1920; 4, 1957-1965); near Orange City (3, 1920, 1929, and 1957); and 3 miles northeast of Osteen (1, 1930).

Christmas Bird Counts were conducted at Daytona Beach in 44 of 58 years from 1910-1967. Scrub Jays were recorded on 37 of those counts, with a maximum of 31 jays in 1958. Christmas counts have been taken in West Volusia Co. (DeLand area) since 1975, and Scrub Jays have been recorded on 4 of those counts. The published total of 106 Scrub Jays in 1975 may be erroneous, as no more than 5 jays have been recorded on any count since then.

According to the Biological Survey files, Scrub Jays have been found at the following places: Coronado, Daytona Beach, Mosquito Inlet Reservation (south of New Smyrna Beach), New Smyrna, Orange City, Ormond, Osteen, and Ponce Park (north side of Ponce de Leon Inlet).

Present. Totals of only 52 adult and 11 juvenile Scrub Jays were found in Volusia Co. in 1981, at 17 localities. Only 6 jays were found at 4 places (Volusia Co. 9, 11, 14, 15) near the coast from New Smyrna Beach northward. Very little undisturbed scrub remains in that area except along SR A1A north of Ormond Beach. The scrub that does remain along SR A1A should be protected from development if at all possible.

No Scrub Jays were found in the relatively undisturbed coastal scrub in Canaveral National Seashore, supporting my contention that Scrub Jays are naturally present in low densities, if at all, in undisturbed coastal scrub (see Chapter 3). W. Hale, who once worked as a Ranger at the Seashore, said (pers. comm.) that she had seen no more than 5 Scrub Jays in the Seashore in 2 and 1/2 years.

Scrub Jays were seen at 3 places (Volusia Co. 7, 8, 12) south of New Smyrna Beach in areas that could be developed any time.

The largest concentration of Scrub Jays in western Volusia Co. is at the Deltona development (Volusia Co. 5-6). Fourteen adult and 5 juvenile Scrub Jays were found there, but they will probably disappear in the face of continuing development of the area.

Ackerman (1958), Hundley (1964), and Steffee and Mason (1971) all reported Scrub Jays at the Enterprise Cemetery. I found no Scrub Jays near the Enterprise Cemetery, even though little development has taken place in the immediate vicinity of the cemetery. The probable cause of the disappearence of jays from that site is natural succession, as the cemetery is now surrounded by mature sand pine scrub.

The only protected Scrub Jay population in the county is on Lake Woodruff National Wildlife Refuge (Volusia Co. 3), and that site supports only a small population of jays.

Only 3 families of Scrub Jays were found in what could loosely be called the Blue Springs area (Volusia Co. 1, 2, 13). Land clearing is not extensive in that area, although some has taken place, but the habitat has succeeded to mature sand pine scrub in most places, with a concommitant decline in the Scrub Jay population.

Scrub Jays have declined substantially in the Daytona Beach and Blue Springs areas as a result of habitat destruction and natural succession. The decline will continue in those two areas, and extend to the Deltona and Edgewater-Oak Hill areas, unless current trends are halted.

Scrub Jays were once common along the Atlantic coast and in the western third of Volusia Co. Unless steps are taken quickly to protect Scrub Jay habitat--which might already be futile--Volusia Co. will have only small, scattered populations of Scrub Jays in 20 years.

Discussion

The future of the Florida Scrub Jay depends on the continued existence of its favored habitat, the scrub. It is unfortunate that most scrub lands are in areas that give them high value as real estate. Much of the coastal scrub has been cleared for beachfront hotels, houses, and condominiums. Scrubs in the interior of the Florida peninsula are subject to development for citrus groves and housing developments. As the human population of Florida continues to grow, pressures to develop scrub lands will increase.

The extent to which Scrub Jays have declined in Florida is not clear, but the decline has been substantial. Scrub Jays have disappeared from 40% of the locations from which they have been reported in the literature or at which Scrub Jay specimens have been collected. That figure does not represent the true extent of the decline because Scrub Jays have been nearly extirpated from several additional areas. I feel confident in stating that the total

population of Florida Scrub Jays has decreased by half in the last 100 years. Scrub Jays have been completely extirpated from Broward, Dade, Duval, Pinellas, and St. Johns Counties, and their numbers have decreased significantly in Brevard, Highlands, Orange, Palm Beach, and Seminole Counties. Clearly, the major cause of the declines and disappearances is habitat destruction. The counties just mentioned include some of the most heavily populated and extensively developed parts of the state. The best way to ensure the survival of Florida Scrub Jays is to preserve their habitat. Being shot by people, being hit by cars, and habitat succession have contributed to population declines in a few local areas, but those factors have had relatively minor effects statewide. They are discussed in more detail in Chapter 3.

Although development has taken place in Florida for many years, the pace of development has accelerated since the 1960's. The human population of Florida nearly doubled from 1960 to 1980, from 4.95 million to 9.75 million (Terhune 1982). That trend will continue into the forseeable future, placing even more pressures on natural habitats.

Most of the housing developments that are located in scrub habitats are less than 20 years old. In many developments, Scrub Jays are barely hanging on, and they will probably disappear in a few years as the land-clearing proceeds. The sites most likely to be destroyed by development in the near future are concentrated in Brevard, Highlands, and Palm Beach Counties. It is possible that no Scrub Jays will remain in Palm Beach Co. by 1990.

The ten largest populations of Florida Scrub Jays contain a minimum of about 14,025 jays, and possibly as many as 21,275 (Table 6). The properties in state or federal ownership, plus Archbold Biological Station, support roughly 12,850-20,050 jays. Approximately 250 Scrub Jays are present in smaller populations on public lands (Table 7). Some clearing is likely to occur on some of the public properties, especially Kennedy Space Center and Cape Canaveral Air Force Station. Nevertheless, if managed properly, the public properties can probably support a combined population of 12,000-19,000 jays indefinitely.

I classified the Scrub Jay populations on private lands according to the apparent likelihood that each site would be developed. High risk sites are those where development is already occurring or appears imminent. Moderate risk sites are those where development is not yet occurring, but may occur in the next few years. Such areas include the few coastal scrubs that have not yet been developed, and inland scrubs near areas of rapid development (such as the Lake Placid area in Highlands Co.). I have also included in the moderate risk category a few developments in which roads have been laid out, but which give little indication of substantial growth in the near future [e.g., Ocala Waterway development in the Big Scrub (Marion Co. 6)]. Finally, I adjudged to have low risks of development those sites that are not located in or near regions of rapid development. Of course, I have no way to predict with certainty the fate of any given Scrub Jay population, and anyone else's assessments of the risks of development would likely differ from mine in several instances. I have indicated in the list of sites (Appendix) which ones are in areas undergoing

Table 6. The ten largest Florida Scrub Jay populations and type of ownership.

Location	County and No.	Estimated Population Size	Ownership*
Merritt Island NWR/ Kennedy Space Center	Brevard Co. 19	6000-10,000	Federal (A)
Cape Canaveral AFS	Brevard Co. 2	3600-6000	Federal (A)
Ocala National Forest	Ocala NF 1-61	2600-3400	Federal (B)
southern Highlands Co.	Highlands Co. 7, 9-27	650	Private (C)
Archbold Biological Station	Highlands Co. 6	400	Private (D)
The Big Scrub	Marion Co. 1,6	250-300	Private (C)
Jonathan Dickinson State Park	Martin Co. 1-6	200	State
Fish-eating Creek Wildlife Management Area	Glades Co. 2-4,9	150	Private
Cedar Key	Levy Co. 2-6	100	State, Private (C)
Lake Arbuckle Road	Polk Co. 7	75	Private
Total birds		14,025-21,275	

*A = some development; B = managed for timber; C = being developed; D = biological preserve; E = Wildlife Management Area, some cleared

Table 7. Small populations of Scrub Jay on public lands.

Location	County and No.	Number seen	Estimated Population Size
Cape Kennedy Regional Airport	Brevard Co. 13	4	8
Valkaria Airport	Brevard Co. 34	14	30
Gold Head Branch State Park	Clay Co. 2	3-7	15
Immokalee Airport	Collier Co. 2	5-10	10
Flagler Beach State Recreation Area	Flagler Co. 1	3	3
Avon Park Bombing Range	Highlands Co. 5, Polk Co. 1-2	23-24	50
Highlands Hammock State Park	Highlands Co. 8	3	5-6
Sebastian Municipal Airport	Indian River Co. 1	3-4	10
Rock Springs Run State Reserve	Orange Co. 2	12-19	35-40
Wekiwa Springs State Park	Orange Co. 8	3	6-10
Lake Kissimmee State Park	Polk Co. 13-14	11-15	30
The Savannahs State Preserve	St. Lucie Co. 5	10-11	20
Oscar Scherer State Park	Sarasota Co. 4	2-5	10
Lake Woodruff National Wildlife Refuge	Volusia Co. 3	4	10
DeLand Municipal Airport	Volusia Co. 4	3	8
Total			250-260

development, so there should be general agreement as to which sites belong in the high risk category. My main purpose in this section is to give an idea of the general magnitude of the problems faced by Scrub Jays. Actual numbers might be off by as much as 25-30% in either direction.

To permit at least crude estimates of total current and future population sizes, I assume that I saw about one-half of the birds present in each population. In some cases, that may severely underestimate the actual population size, but it is probably as good a guess as any.

In high risk areas, I saw approximately 575 Scrub Jays in 1981. I expect Scrub Jays to be virtually, if not completely, extirpated from all of the high risk sites in 10-20 years. A total of well over 1000 jays thus might have their habitat destroyed in those areas. Roughly 300 jays, representing a total of perhaps 600 birds, were seen in areas of moderate risk. If we assume that about one-half of the moderate risk sites are developed, and the remainder is left intact, about 300 Scrub Jays might survive indefinitely on those sites. Finally, approximately 240 Scrub Jays were found in low risk sites. Most of these sites support relatively small jay populations--no more than 14 jays were seen at any of the sites, and 5 or fewer jays were seen at most of the sites. The habitat at some of the "low risk" sites probably will be cleared in the future, but the number of birds lost in any one of those populations is likely to be small. Still assuming that the number of birds seen represents about one-half of the total, as many as 480 Scrub Jays may exist on the low risk sites.

I estimate the total number of Florida Scrub Jays to be 15,330-22,530, consisting of 13,100-20,300 on public lands and about 2230 on private property.

Adding together the 12,000-19,000 Scrub Jays that should survive indefinitely on protected property, the 300 on moderate risk private property, and the 480 on low risk private property, I arrive at a figure of 12,780-19,780 Florida Scrub Jays that may exist indefinitely into the future.

Although Scrub Jays are present in local areas scattered throughout the Florida peninsula, the great bulk of the population is concentrated in two general areas: Merritt Island/Cape Canaveral and Ocala National Forest. Because those areas contain over 80% of the known population of Florida Scrub Jays, it is imperative that the federal agencies responsible for them (U. S. Fish and Wildlife Service and National Aeronautics and Space Administration for Merritt Island National Wildlife Refuge/Kennedy Space Center, U. S. Air Force for Cape Canaveral Air Force Station, and U. S. Forest Service for Ocala National Forest) manage the areas properly, with concern for Scrub Jays and all scrub organisms, to prevent a drastic decrease in Scrub Jay numbers.

The future of Florida Scrub Jays seems secure in some areas, but efforts should still be made to protect other, smaller populations in order to maintain the genetic variability of Scrub Jays and to provide examples of the various types of scrub. In the county discussions, I have tried to indicate some of the areas that should be preserved. Those areas include the following: 1) private lands adjacent to Gold

Head Branch State Park (Clay Co. 2), the northernmost population of Florida Scrub Jays; 2) scrub portions of Fish-eating Creek Wildlife Management Area (Glades Co. 2-4, 9), a large and isolated population; 3) three sites in Highlands Co. (Highlands Co. 16, 27, 30), especially scrub along US 27, south of Lake Placid; 4) private lands adjacent to Cedar Key Scrub State Preserve (Levy Co. 2-6), the northwesternmost Florida Scrub Jay population; 5) undeveloped portions of The Big Scrub (adjacent to Marion Co. 1, 6); 6) scrub along Lake Arbuckle Road, southeast of Frostproof (Polk Co. 7); and 7) private lands adjacent to Oscar Scherer State Park (Sarasota Co. 4, 5), soon likely to be the only population on the southwest Gulf Coast. In addition, any relatively undisturbed coastal scrub should be protected, even if Scrub Jays are absent, or it will soon be developed.

In spite of the problems faced by Scrub Jays, they have managed to survive, for the most part, wherever their habitat has not been completely destroyed, including some extremely unlikely situations. Scrub Jays persist in some areas with no more than a few scrub oaks by the side of a road, surrounded by pastures, citrus groves, or pine plantations (see Chapter 3).

CHAPTER 3
MANAGEMENT OF FLORIDA SCRUB JAY POPULATIONS

Several authors have commented on the types of habitats used by Florida Scrub Jays. Westcott (1970) wrote that Scrub Jays require "low, dense, largely evergreen oak thickets for nesting and extensive open space for feeding" (p. 68). Similarly, Woolfenden (1973) wrote that Scrub Jays inhabit "oak scrub, composed of low dense thickets with numerous open sandy spaces," and added that the "critical factors in the habitats they avoid seem to be abundance of trees and absence of open sandy spaces" (p. 26).

As discussed previously, the single most important step that can be taken to ensure the survival of the Florida Scrub Jay is to preserve its habitat. Once a Scrub Jay population is protected, however, it may be necessary to take certain measures to increase the population size, or at least to prevent its decrease. In an attempt to determine how to best manage protected populations, in 1982 I conducted an investigation of the relationships between Scrub Jay population density and habitat structure. The purposes were to correlate population density with habitat structure in sites with Scrub Jays and to examine the structural differences of habitats with and without Scrub Jays.

Prior to this study, the only quantitative analysis of Florida Scrub Jay habitats was that of Breininger (1981), who studied Scrub Jay habitat use at Merritt Island National Wildlife Refuge, Brevard Co.,

Florida. He found significant positive correlations between Scrub Jay population density and percent open space (bare ground or vegetation less than 15 cm in height), percent of vegetation composed of oaks, shrub layer height, density of small trees (diameter at breast height of 2.5-5.1 cm), and acorn production. He found a significant negative correlation between population density and percent cover by palmettoes. No correlation was found between population density and overall percent cover by oaks. Breininger's (1981) study sites did not include samples of all types of scrub, and his work was restricted to one small part of the state. Therefore, I felt that it would be worthwhile to sample a wider range of habitats from different parts of the state.

In addition to the quantitative analysis, I have included a discussion of some of the more unusual habitats in which I found Scrub Jays during the statewide survey. I also discuss some of the factors that may be involved in the restriction of Florida Scrub Jays to largely treeless scrub habitats.

Procedures

Habitat measurements and population censuses were made for 7 Scrub Jay populations; habitat measurements were also made in 8 sites without Scrub Jays. Locations and descriptions of each site are given below. Four of the sites with jays and 7 of the sites without jays were located in Ocala National Forest.

Scrub Jay population estimates were obtained by censusing each site at least 3 or 4 times during the 1982 breeding season. On each visit, I walked through the site, playing a tape recording of Scrub Jay

predator "screech scold" calls (Barbour 1977). These harsh scold notes are given in the presence of terrestrial predators (especially snakes), and attract all members of a family and occasionally jays from neighboring territories (Barbour 1977; pers. obs.). Birds were counted and their locations plotted on a map. By making several visits to each site, territory boundaries could be roughly plotted, and the number of birds in each territory determined.

Because the species of oaks found in the scrub frequently reproduce vegetatively, and because they tend to grow in irregularly shaped clumps, it is sometimes difficult to determine where one individual ends and the next begins. Furthermore, a clump of a given size may contain anywhere from one to several dozen stems, so a stem count would be misleading. Scrub Jays respond to the overall size of the clump, not to the number of stems or individual plants it contains. What I needed was a way to measure percent cover--the percentage of ground covered by each type of plant. In addition, I deemed a measure of vegetation height important.

The technique I adopted was a modification of the point-intercept method (Mueller-Dombois and Ellenberg 1974), which permits estimation of percent cover by different species or general vegetation types. I modified the technique to allow vegetation measurements to be made over a large area, and to include measurements of vegetation height as well as cover. It proved to be a straightforward and relatively easy method for obtaining habitat data. It may not be as precise as certain other sampling methods, but I am confident that the data obtained with this technique are adequate for the purposes at hand. Using the modified

point-intercept technique, a person with minimal training can readily determine what steps, if any, need to be taken to increase, or prevent the decrease of, the number of Scrub Jays in a population.

The procedure was as follows: at each site, 20 transects were laid out in a stratified random manner. Transects were 25 m long, and oriented in randomly chosen directions. At 1 m intervals along each transect, I recorded the type and height of the tallest plant in each of two strata: $\leq$3 m, and >3 m. If an individual plant extended into both strata, it was recorded only for the upper stratum. If (and only if) no plant was present in the lower layer, ground cover was recorded using the following categories: leaf litter (including disintegrated logs and branches), bare ground, lichen, log, or moss. Shrubs and trees were identified to species. Grasses and forbs were recorded only as belonging to those general groups. I thus recorded one datum for vegetation $\leq$3 m tall at each of 500 points per site, and one datum for vegetation (if any) >3 m tall, at each of a variable number of points (up to 500) per site. Counts were converted to percentages by dividing by 500. Plant heights were recorded in the following intervals: 0.0-0.5 m, 0.5-1.0 m, 1-2 m, 2-3 m, 3-4 m, 4-5 m, 5-6 m, 6-8 m, 8-10 m, 10-12 m, 12-15 m, and >15 m. In this report, I have not used all of the variables I measured. The variables I did use are defined in Table 8.

Although many of the variables I measured were highly correlated with one another, I was unable to use certain multivariate statistical techniques because of the small sample size. Nevertheless, I did in one case perform a partial correlation analysis on the

Table 8. Abbreviations and definitions of habitat variables.

Abbreviation	Definition
TOAK	% coverage by oaks up to 3 m tall
OAKZ	% coverage by oaks 0.0-0.5 m tall
OAKZ-1	% coverage by oaks 0.5-1.0 m tall
OAK1-2	% coverage by oaks 1.0-2.0 m tall
OAK2-3	% coverage by oaks 2.0-3.0 m tall
TSHB	% coverage by non-oak shrubs up to 3 m tall
SHBZ	% coverage by non-oak shrubs 0.0-0.5 m tall
SHBZ-1	% coverage by non-oak shrubs 0.5-1.0 m tall
SHB1-2	% coverage by non-oak shrubs 1.0-2.0 m tall
SHB2-3	% coverage by non-oak shrubs 2.0-3.0 m tall
PINZ-10	% coverage by pines (all species) up to 10 m tall
CANCVR	% coverage by all plants greater than 3.0 m tall
GRASS	% coverage by grass of any height
BGD	% coverage by bare soil

arcsine-transformed data (Sokal and Rohlf 1981) in order to examine the independent effects of some of the habitat variables on Scrub Jay density.

Descriptions of Study Sites

Sites with Scrub Jays

CRMP--in Crystal Manor Development, E of US 19-98, about 14 km (8 mi) NNW of Crystal River, Citrus Co., Florida (Citrus Co. 2); bordered on west and south by Carnation, on east by Dawnflower, and on north by Fig Tree; includes SE corner Sec 12, NE corner Sec 13, T17S, R16E, and SW corner Sec 7, NW corner Sec 18, T17S, R17E; estimated 11.7 Scrub Jays/40 ha in 1982; area = 24 ha; atypical Scrub Jay habitat; mostly grass and blackberries with scattered clumps of oaks; scattered pines; surrounded by similar habitat; some houses about 100 m away, but none within study area in 1982; paved roads bounding and passing through area.

ABSP--Archbold Biological Station, 14 km (8 mi) S Lake Placid, Highlands Co., Florida (Highlands Co. 6); bounded on north by First Burn Road, on west by Water Hole Road and North Swale Road, on south by North Nineteen Road, and on east by Seaboard Coast Line Railroad; mostly within W 1/2 of SE 1/4 Sec 18, T38S, R30E; estimated 8.7 Scrub Jays/40 ha in 1982; area = 33 ha; 1-2 m oak scrub, surrounded by similar habitat; seasonal pond in SE corner, surrounded by slash pines; burned in January 1977.

BGSP--Ocala Waterway Development, about 14 km (8 mi) W of Belleview, Marion Co., Florida (Marion Co. 6); part of "The Big

Scrub"; NW 1/4 of SE 1/4 Sec 27, T16S, R21E, and some adjacent land; estimated 19.3 Scrub Jays/40 ha in 1982; area = 23 ha; dense 1-2 m oak scrub; burned 16 May 1977; surrounded by similar habitat; dirt roads, none maintained, bounding and passing through area.

F71P--Ocala National Forest, Marion Co., Florida (Ocala NF 31); Compartment 84, Stands 8 and 39; E and W of FR 97, 3.4-3.8 km (2.15-2.4 mi) N SR 40; S 1/2 Sec 3, NE 1/4 Sec 10, T15S, R25E; estimated 23.6 Scrub Jays/40 ha in 1982; area = 22 ha; 2-3 m oak scrub, scattered 10-15 m sand pines; regenerated in 1971; surrounded by stands of different ages; portion west of FR 97 was cleared in 1983.

F73P--Ocala National Forest (Ocala NF 23); Compartment 50, Stand 16; E side FR 97, 0.3-0.6 km (0.2-0.4 mi) S C-314; NE 1/4 Sec 7, T14S, R25E; estimated 17.9 Scrub Jays/40 ha in 1982; area = 24 ha; 1-2 m scrub oaks, 6-8 m sand pines; regenerated in 1973; surrounded by stands of different ages.

F75P--Ocala National Forest (Ocala NF 55); Compartment 274, Stand 11; E side FR 66, 1.4-2.1 km (0.85-1.3 mi) S FR 73; SW 1/4 Sec 3, NW 1/4 Sec 10, T17S, R26E; estimated 21.8 Scrub Jays/40 ha in 1982; area = 22 ha; 1-2 m scrub oaks, 3-4 m sand pines, regenerated in 1975; surrounded by stands of different ages.

F78P--Ocala National Forest (Ocala NF 1); Compartment 2, Stand 6; W side FR 97, 0.2-0.7 km (0.15-0.45 mi) S FR 77; SE 1/4 Sec 26, T11S, R24E; estimated 14.3 Scrub Jays/40 ha in 1982; area = 25 ha; 1-2 m scrub oaks and sand pines; regenerated in 1978; surrounded by stands of different ages.

Sites without Scrub Jays

F28N--Ocala National Forest; Compartment 228, parts of Stands 25, 26, and 29; W side of FR 79, about 2.4-3.2 km (1.5-2.0 mi) N of FR 95; E 1/2 of NW 1/4 Sec 4, T16S, R25E; no Scrub Jays; about 0.3 km (0.2 mis) from nearest Scrub Jay population; mature sand pine scrub, 10-15 m tall, rather open understory; part of much larger forested area, all of similar structure.

F68N--Ocala National Forest; Compartment 14, Stand 31; immediately SW of junction of FR 31 and FR 97; NE 1/4 Sec 11, T12S, R24E; no Scrub Jays; Scrub Jays present in stand immediately to NE of junction of FR31 and FR 97; dense 6-8 m sand pines, many scrub oaks up to 2 m tall; regenerated in 1968; surrounded by stands of different ages.

F69N--Ocala National Forest; Compartment 50, Stand 1; immediately N of junction of C-314 and FR 67; SE 1/4 Sec 1, NE 1/4 Sec 12, T14S, R24E, and NW 1/4 Sec 7, T14S, R25E; no Scrub Jays; 0.16 km (0.1 mi) from nearest Scrub Jay population; dense 6-8 m sand pines, many scrub oaks 1-3 m tall; regenerated in 1969; surrounded by stands of different ages.

F72N--Ocala National Forest; Compartment 84, Stand 4; W side FR 97, roughly 2.2-3.4 km (1.35-2.15 mi) N SR 40; SE 1/4 Sec 10, T15S, R25E; no Scrub Jays; Scrub Jays present in stand on north side; dense 5-8 m sand pines, many scrub oaks up to 2 m tall; regenerated in 1972; part of much larger stand.

F73N--Ocala National Forest; Compartment 27, Stand 13; W side FR 97, 1.4-2.2 km (0.9-1.4 mi) N C-316; SE 1/4 Sec 2, NE 1/4 Sec 11, T13S, R24E; no Scrub Jays; Scrub Jays present in stand on south side; 4-6 m

sand pines, many scrub oaks up to 2 m tall; regenerated in 1973; surrounded by stands of different ages.

F76N--Ocala National Forest; Compartment 272, Stand 4; immediately NE of junction of FR 66 and FR 73; SW 1/4 Sec 34, T16S, R26E; no Scrub Jays; 1.4 km (0.85 mi) from nearest known Scrub Jay population; 2-4 m sand pines, few oaks, very open habitat; regenerated in 1976; surrounded by stands of different ages.

F80N--Ocala National Forest; Compartment 253, Stand 1; S side FR 95, 2.4-3.2 km (1.5-2.0 mi) W FR 88; NW 1/4 Sec 14, T16S, R25E; no Scrub Jays; Scrub Jays present in stand on SW side; I predict they will colonize this stand within 2-3 years; scrub oaks and sand pines less than 1 m tall; regenerated in 1980; part of large stand, surrounded by stands of different ages.

ABSN--Archbold Biological Station; approximately 200 m NE of station buildings; SE 1/4 Sec 7, SW 1/4 Sec 8, T38S, R30E; Scrub Jays occasionally seen on plot, but not resident there since 1978 (Woolfenden and Fitzpatrick MS); dense oak scrub 2-3 m tall, unburned since 1926-27, surrounded by similar habitat; includes scrubby flatwoods plot of Woolfenden (1969, 1970).

Results

Correlation coefficients between Scrub Jay population density (POPDEN) and selected habitat variables are shown in Table 9. Table 10 presents comparisons of those same variables in habitats with and without Scrub Jays. Four variables--SHBZ-1, TOAK, SHBZ, and OAK2-3--were significantly correlated with POPDEN. Correlations between POPDEN and OAK1-2 and GRASS were almost significant.

Table 9. Spearman rank correlation coefficients among habitat variables and Scrub Jay population density. Variables are defined in Table 8. n = 7. *,P<0.05; **,P<0.01.

	POPDEN	TOAK	OAKZ	OAKZ-1	OAK1-2	OAK2-3	TSHB	SHBZ	SHBZ-1	SHB1-2	SHB2-3	PINZ-10	CANCVR	GRASS
TOAK	0.786*													
OAKZ	0.036	0.036												
OAKZ-1	0.571	0.643	0.750*											
OAK1-2	0.667	0.937**	0.126	0.631										
OAK2-3	0.775*	0.721*	-.360	0.162	0.727*									
TSHB	-.429	-.536	0.071	-.357	-.360	-.090								
SHBZ	-.786*	-.893**	0.071	-.571	-.829*	-.667	0.714*							
SHBZ-1	-.883*	-.901**	-.072	-.703	-.782*	-.636	0.667	0.955**						
SHB1-2	0.500	-.107	0.143	0.071	-.180	0.234	0.143	0.071	-.090					
SHB2-3	0.324	0.108	-.288	-.180	0.282	0.718*	0.486	-.126	-.064	0.360				
PINZ-10	0.357	0.250	0.357	0.286	0.450	0.504	0.464	-.036	-.072	0.429	0.667			
CANCVR	0.396	0.144	-.432	-.252	0.282	0.736*	0.198	-.270	-.154	0.396	0.927**	0.522		
GRASS	-.685	-.522	-.288	-.468	0.646	-.727*	-.198	0.378	0.436	-.504	-.691	-.919**	-.600	
BGD	0.214	0.250	0.143	0.214	0.000	-.126	-.357	0.000	-.162	0.143	-.613	-.143	-.577	0.108

Table 10. Comparisons of selected habitat variables (percent cover) in habitats with (PRESENT) and without (ABSENT) Florida Scrub Jays.

	PRESENT	ABSENT		
	$\bar{X}$ (range)	$\bar{X}$ (range)	Mann-Whitney U-statsitic	Probability
TOAK	46.8% (17.0-68.8%)	43.2% (21.6-68.8%)	31.5	0.685
OAKZ	6.6% (2.4-13.0%)	8.6% (1.4-25.2%)	26.0	0.817
OAKZ-1	15.0% (9.4-30.8%)	11.5% (5.8-17.0%)	34.5	0.450
OAK1-2	18.6% (3.0-27.0%)	17.9% (1.8-41.0%)	33.5	0.524
OAK2-3	6.6% (0.4-25.6%)	5.2% (0.0-16.8%)	29.0	0.908
TSHB	18.7% (3.6-34.0%)	27.0% (14.6-36.6%)	12.0	0.064
SHBZ	5.3% (1.4-12.6%)	6.0% (2.8-12.4%)	23.5	0.602
SHBZ-1	8.3% (1.8-19.6%)	7.0% (4.6-11.6%)	30.0	0.816
SHB1-2	2.6% (0.4- 5.4%)	8.6% (1.4-16.6%)	7.0	0.015
SHB2-3	2.6% (0.0- 7.6%)	5.4% (0.0-12.3%)	18.0	0.246
PINZ-10	11.7% (1.4-38.8%)	34.3% (1.4-60.6%)	13.5	0.093
CANCVR	7.6% (0.0-31.0%)	35.7% (0.0-73.6%)	12.5	0.063
GRASS	6.2% (0.0-24.4%)	1.0% (0.0- 4.4%)	35.5	0.376
BGD	7.6% (2.2-15.8%)	6.2% (0.2-21.6%)	38.0	0.247

Table 9 also shows correlations among the various habitat variables. TOAK was negatively, and highly significantly, correlated with SHBZ and SHBZ-1. In a partial correlation analysis, SHBZ and SHBZ-1 were not significantly correlated with POPDEN once the correlation of POPDEN with TOAK is considered. In my study sites, TOAK ranged from 17.0-68.6%, SHBZ from 1.4-12.6%, and SHBZ-1 from 1.8-19.6% (Table 10).

I did not measure shrub height directly, but I have calculated Spearman rank correlations between Scrub Jay density and percent cover by all shrubs, including oaks, of different size classes on my study sites. For shrubs 0.0-0.5 m tall (= OAKZ + SHBZ), $r_s = -0.607$ $P>0.05$); for shrubs 0.5-1.0 m tall (OAKZ-1 + SHBZ-1), $r_s = -0.393$ ($P>0.05$); for shrubs 1.0-2.0 m tall (OAK1-2 + SHB1-2), $r_s = 0.929$ ($P<0.01$); and for shrubs 2.0-3.0 m tall (OAK2-3 + SHB2-3), $r_s = 0.750$ ($P<0.05$).

The only variable that was significantly different in habitats with and without Scrub Jays was SHB1-2 (Table 10). The values for PINZ-10 and CANCVR were significant at the P = 0.10 level. The habitats without Scrub Jays had greater percent coverage by shrubs 1-2 m tall, greater canopy cover above 3 m, and more pines 0-10 m tall, than habitats without Scrub Jays. Neither SHB1-2, PINZ-10, nor CANCVR was significantly correlated (positively or negatively) with Scrub Jay population density in habitats with Scrub Jays (Table 9). SHB1-2 reached a maximum of only 5.4% cover at any of the Scrub Jay sites (F75P). PINZ-10 had values greater than 11% at only two sites (F73P and F75P), and CANCVR had a value of greater than 10% at only one site (F73P).

There was no difference in the percent coverage by oaks in habitats with and without Scrub Jays (Table 10). Some habitats without Scrub Jays had as many oaks as any Scrub Jay habitat, and some Scrub Jay habitats had relatively few oaks (e.g., at CRMP, TOAK = 17.0%).

Discussion

The apparent conclusion to be drawn from the correlational data (Table 9) is that Scrub Jay population densities can be increased most effectively by increasing the percent coverage by oaks (TOAK), especially oaks 1-3 m tall (OAK1-2 and OAK2-3), and reducing the percent coverage by grasses (GRASS) and non-oak shrubs less than 1 m in height (SHBZ + SHBZ-1).

Because of the negative correlation of TOAK with SHBZ and SHBZ-1, and the fact that SHBZ and SHBZ-1 accounted for a relatively small proportion of the vegetation at my study sites, I doubt that reducing the number of non-oak shrubs in Scrub Jay habitat would increase the number of Scrub Jays, unless there was a simultaneous increase in the number of oaks.

The fact that only one variable was significantly different in habitats with and without Scrub Jays (Table 10) is perhaps not surprising, considering that the habitats without Scrub Jays are not all alike. A few plant species and the lack of Scrub Jays are all that the habitats without Scrub Jays had in common. At F76N and F80N, the oaks were either too sparse or too short to support Scrub Jays. At all of the other non-Scrub Jays sites, the vegetation was taller and denser than most Scrub Jay habitats. F28N, F68N, F69N, F72N, and F73N all had greater values of CANCVR than any of the sites with Scrub Jays.

Although jay density was highly correlated with percent coverage by oaks (Table 9), some scrub habitats without Scrub Jays had as many oaks as those with Scrub Jays (Table 10). Other factors must be involved in the absence of Scrub Jays from certain scrub habitats.

As discussed in the Introduction to this section, Breininger (1981) examined habitat use by Scrub Jays at Merritt Island National Wildlife Refuge (MINWR), Brevard Co., Florida. Breininger used the line-intercept method (Mueller-Dombois and Ellenberg 1974) to measure percent coverage by different plant species along a 400-m transect in each of 25 different study areas and used two different methods to estimate Scrub Jay population densities along slightly different subsets of the 25 vegetation transects. The two methods--the "Alarm Call Census" (20 transects) and the "BAL" method (23 transects)--were described previously in this paper, in the discussion of Brevard Co. The results of the two census techniques were generally very similar.

Some of the correlations Breininger (1981) found between habitat structure and Scrub Jay density are listed in Table 11. The strongest correlation he found was between Scrub Jay density and percent open space (bare ground or vegetation <15 cm tall). In contrast to my study, he found no significant correlation between jay density and overall oak cover (comparable to TOAK of my study), although he did find a significant correlation between jay density and percent of vegetation covered by oaks. For some variables, he found that curvilinear (quadratic) models fit the data better than linear models. In particular, the BAL estimate of jay density peaked at an open space value of 20-50%, and decreased with both greater and lesser values of

Table 11. Correlations and regression equations between selected habitat variables and Scrub Jay population density at Merritt Island National Wildlife Refuge, Florida (from Breininger 1981). X = independent (habitat) variable. *,P<0.05; **,P<0.01.

Variable	Equation (if significant)	R	Range	Value for maximum density (if significant)
% transect covered by palmettoes	$BAL = -0.00412X - 0.00052X^2 + 2.21285$	0.63**	5-70%	20%
% open space	$ALARM = 0.12298X - 0.00121X^2 + 0.42357$	0.89**	0.6-47.5%	20-48%
	$BAL = 0.14819X - 0.00198X^2 + 0.07192$	0.88**	0.6-76.1%	20-50%
% vegetation covered by oaks	$BAL = -0.02159X + 0.00069X^2 + 0.52900$	0.63**	4.3-71.0%	60-70%
% transect covered by oaks	not significant	0.37	3.6-65.9%	
mean height of shrub layer	$ALARM = 0.76674X - 0.00312$	0.59*	1.0-3.5 m	1.8-3.5 m
density of small tress (#/ha)	$BAL = 0.17176X - 0.00295X^2 + 0.73216$	0.72**	0-762	50-400

open space. Breininger also found a parabolic relationship between population density and density of small trees (diameter at breast height of 2.5-5.1 cm). In that case, however, there was only one transect that had a high value (well above the midrange) of small trees and a low population density.

Breininger (1981) found a significant linear correlation between population density and mean shrub layer height, up to a shrub height of 3.5 m. He was unable to find any habitats with mean shrub heights between 3.5 and 5.0 m, but found no Scrub Jays in habitats with shrubs averaging over 5.0 m in height. There was considerable scatter in the relationship between jay density and shrub height: areas with densities of over 120 birds/40 ha had average shrub heights of 1.8-3.5 m, and one area with a mean shrub height of 3.3 m had a density of only 20 jays/40 ha (ibid., Table 15). Furthermore, of the 12 areas in which Breininger found densities $\geq$40 birds/40 ha, all did have mean shrub heights >1.5 m, but nine of the 12 also had open space values >20%.

Breininger (1981) also found significant correlations between Scrub Jay density and acorn density and certain measures of winter insect abundance, but not between jay density and any measure of summer insect abundance. Scrub Jays at MINWR may be food-limited in winter, but are apparently not food-limited in summer.

Finally, Breininger (1981) conducted a multiple regression analysis to determine which combination of variables is most important in determining Scrub Jay population density. The equation he developed is: BAL density = $0.11981(\text{OPEN}) - 0.00152(\text{OPEN})^2 - 0.01100(\text{OAK}) + 0.00033(\text{OAK})^2 - 0.97484(\text{HT}) + 0.24878(\text{HT})^2 + 0.77554$, where OPEN = %

open space (bare ground or vegetation <15 cm tall), OAK = % of vegetation comprised of oaks, and HT = mean height of shrub layer. The variables included in the equation accounted for 84% of the variance in Scrub Jay density (R^2 = 0.84). It is apparent from the multiple regression equation and the foregoing discussion that oak density, mean shrub height, and amount of open space are among the most important factors in determining Scrub Jay density.

In comparing Breininger's (1981) results with mine, the most striking difference is that some of the population densities he found were much higher than any I found. As discussed in the summary of Scrub Jay distribution in Brevard Co. (Chapter 2), Breininger found the highest densities ever reported for Florida Scrub Jays. It is probable that the very high densities Breininger found are restricted to a few local areas. All of the transects on which Breininger found densities greater than 40 birds/40 ha were in areas with 19-55% oak coverage and 10-60% open space. Most of the high density areas are disturbed areas, where roads, construction, or other activities of the Kennedy Space Center have created large open spaces next to dense oak thickets. Scrub Jays nest and gather acorns in the oak thickets and cache acorns and forage for other types of food, especially arthropods and lizards, in the open areas. With two exceptions, all the rest of Breininger's transects had less than 10% open space and jay densities $\leq$32 birds/40 ha. My study sites were relatively undisturbed. Although some of my sites had roads or jeep trails passing through them, none had over 16% bare ground, a variable roughly comparable to Breininger's open space variable. The highest density I found was 23.6 jays/40 ha.

Areas with less than about 15% open area or bare ground have relatively low densities (<40 jays/40 ha) of Scrub Jays, regardless of the density of oaks. Breininger's other 2 transects had open space values >55%, oak cover values <10%, and jay densities of 20 and 40 birds/40 ha, respectively.

Breininger's (1981) finding that Scrub Jay density is negatively correlated with the percent of each transect covered by palmettoes (Table 11) corresponds roughly to my finding of a negative correlation between jay density and percent coverage by all non-oak shrubs less than 1 m tall. In my study, the negative correlation between shrub cover and jay density was due to a negative correlation between shrub cover and oak cover: where there are many non-oak shrubs, there can be few oaks, and hence few jays. I suspect that the same was true for Breininger's study sites.

As mentioned above, Breininger found a significant positive correlation between jay density and mean shrub layer height. I also found that Scrub Jays were most common in habitats with high percent cover by shrubs (including oaks) 1-3 m tall, and low percent cover by shrubs 0-1 m tall. In Ocala National Forest, regenerating stands are not colonized by Scrub Jays until the shrubs are about 1 m tall. One of my Forest stands (F80N) was regenerated 2 years before my study, and had a high coverage (40%) by oaks under 1 m tall. Scrub Jays did not inhabit that stand, but did inhabit an adjacent stand that was 5 years older and had numerous oaks 1-2 m tall. I predict that Scrub Jays will colonize the younger stand by the time it is 5 years old, but at the time of my study, the jays clearly preferred the older stand. Another

stand, cleared in 1979, was adjacent to one of my study sites (F73P). The oaks in the 1979 stand averaged just under 1 m in height in 1982, and there were extensive areas of bare sand. At least one family of jays nested (successfully) in the stand in 1982. At that time, the oaks were just achieving the minimum height necessary for Scrub Jays to be attracted to the stand. I am sure that more jays would have colonized the area over the next few years as the oaks grew taller and provided better nest sites and shelter. Unfortunately, because very few sand pines were growing in that stand, the Forest Service had it cleared in fall, 1982, so that sand pines could be reseeded.

Oaks less than 1 m tall provide less protection from the weather and from predators than taller oaks and probably provide inferior nest sites. Woolfenden (1973) indicated that Scrub Jays prefer nest heights of 1.4-2.0 m, when given a choice of nest heights. Taller shrubs also support more insects in winter (Breininger 1981).

When a family of Scrub Jays is foraging together, one bird usually acts as a sentinel, perching on the highest nearby perch to watch for predators and trespassing Scrub Jays (Westcott 1970; pers. obs.). Having a few trees in a territory to serve as perches can improve the quality of the territory, but an abundance of large trees blocks the sentinel's view and decreases the territory quality. Breininger (1981) found that Scrub Jay density increased with the density of small trees up to a density of about 400 trees/ha (Table 11). Only one of his transects had a tree density much higher than that--762 trees/ha--and it had a BAL density estimate of only 20 birds/40 ha. He found a slightly positive, but not significant, correlation between jay density

and density of large trees (diameter at breast height >5.1 cm), but none of his transects had more than 88 large trees/ha. That density of trees represents a very open woodland.

Of my study sites, the ones without Scrub Jays generally had greater canopy cover (more trees) than the ones with Scrub Jays (Table 10). Of the more than 300 locations at which I have seen Florida Scrub Jays (Appendix), none had more than about 50% canopy cover above 3 m, and many of the locations had no trees at all. In Ocala National Forest, I visually estimated percent coverage by sand pines in several stands 5-12 years old, the age of stands usually inhabited by Scrub Jays in the Forest (Table 5). No stand with Scrub Jays had more than 40% canopy cover, but most of the stands lacking Scrub Jays had 50-80% sand pine coverage. Scrub Jays might be expected to invade sand pine scrub, since the plant species there are the same as in the open oak scrub typically occupied by Scrub Jays. The physical structures of the two habitats are quite different, however, and Scrub Jays do not inhabit sand pine scrub. This problem is discussed further below.

Scrub Jays at Archbold Biological Station.--Woolfenden (1969, 1970) censused the breeding and wintering birds of the five major natural habitats at Archbold Biological Station: sand pine scrub; "low flatwoods" (dominated by slash pine); "slash pine-turkey oak association"; "scrubby flatwoods" (= oak scrub); and "recently burned scrubby flatwoods." Scrub Jays were resident only in the last three habitats and are rarely, if ever, seen in the first two habitats (C. E. Winegarner, cited in Woolfenden 1973; pers. obs.). The sand pine scrub and low flatwoods are forest habitats, which are not

inhabited by Scrub Jays (see above). Since 1970, Scrub Jays have disappeared as resident of the scrubby flatwoods area, having last nested there in 1978 (Woolfenden and Fitzpatrick MS). It is because Scrub Jays have only recently disappeared from the scrubby flatwoods area that I chose it as one of my non-Scrub Jay sites (ABSN). From 1969, when Woolfenden began his studies of the Archbold Scrub Jays, to 1979, the number of Scrub Jay territories in that area decreased from four to zero (Woolfenden and Fitzpatrick MS). Scrub Jays remain as common residents in the recently burned scrubby flatwoods habitat (ABSP) and are apparently still residents on at least the edges of the slash pine-turkey oak association. Whereas ABSP has burned regularly, ABSN has not been burned since 1926-27. Therein, I believe, lies the explanation for the disappearance of Scrub Jays from ABSN and their continued existence on ABSP. The vegetation on ABSN is taller and denser than at ABSP, with less open space.

Because ABSN has not burned for over 50 years, succession has progressed to the point where virtually all previously bare ground is now covered by plants. The only open areas remaining in ABSN are the trails and fire breaks, and they apparently provide insufficient open space for Scrub Jays. Photographs taken at Archbold Biological Station in the 1930's, within 10-12 years after the last fire in the scrubby flatwoods, reveal a very low, open habitat, very similar to the present appearance of the regularly burned scrubby flatwoods. It was possible to look over the shrubs to see the station's buildings for a great distance. The plants have since grown up, and one's view of the buildings is obscured as soon as one enters the scrub.

Fire.--Fire is an important factor and valuable management tool in maintaining the suitability of scrub for Scrub Jays. In the absence of fire, the scrub vegetation continually increases in height and coverage, eventually obliterating all open spaces, and causing a decrease in Scrub Jay density. How long it takes for Scrub Jays to abandon a long-unburned scrub is not certain. The tall, unburned scrubby flatwoods area at Archbold is the only site for which good data exist showing a decline in Scrub Jay density in the absence of fire. As discussed above, it took just over 50 years for Scrub Jays to abandon the area.

Much of the extensive tract of scrub north of Cedar Key last burned in 1956. Some of that scrub still supports Scrub Jays, but jays are absent from areas consisting of dense oak thickets over 2 m tall, with few open spaces. If Scrub Jays once occupied those areas, it took them only about 25 years to abandon them. Depending on the growth rate of the scrub vegetation, fires need to occur at least every 20-30 years if the scrub is to remain suitable for Scrub Jays.

On the other hand, burning scrub too often can be just as bad as burning it too seldom. Scrub oaks need to attain heights of at least 1 m before they provide adequate Scrub Jay habitat, and the quality improves as the oaks grow taller, up to a maximum of 3.0-3.5 m. The length of time oaks require to reach a height of 1 m varies with the site; soil nutrients and rainfall are probably critical factors. Two of my study sites (ABSP and BGSP) were both burned in 1977. At the Archbold site, some areas were burned completely (killing and charring all vegetation), while other areas were left untouched by the fire

(Archbold Biological Station, unpublished records). Most of the woody vegetation in the areas that had been completely burned was still less than 1 m tall in 1982. In contrast, it appears that all of the Big Scrub study site burned completely in 1977. In 1982, the area was covered by dense oak thickets 1.0-1.5 m tall. Because of the greater height and density of the shrubs, I found walking through the Big Scrub site much more difficult than walking through the Archbold site.

Regular burning of the scrub on a 3-5 year cycle would be the maximum frequency at which a population of Scrub Jays could be maintained, even at a low density. A fire frequency of 15-20 years might allow the vegetation to grow too tall and dense, also resulting in a low jay density. Also, the longer the time between fires, the more intensely a fire will burn and the harder it will be to control. The precise frequency at which any stand should be burned to provide optimal jay habitat will depend upon several factors, especially the growth rate of the scrub oaks, which is in turn influenced by soil nutrients and the amount of rainfall.

In the past, Scrub Jays have managed to survive regular fires, some of which must have burned all the vegetation in entire territories. There was also more habitat available for Scrub Jays to move into if necessary. Development of Florida has drastically reduced the amount of Scrub Jay habitat, so caution must be exercised in developing and carrying out a program of controlled burning, to ensure both that the fire does not threaten life or property and that adequate habitat remains after the fire.

Scrub fires frequently burn in mosaic patterns, leaving only blackened stems in some areas while skirting other areas, but it is impossible to predict how a particular fire will burn. The best procedure would be one that would create a mosaic of unburned and recently burned habitat, so that the jays will always have both dense oak thickets for nesting and gathering acorns, and open areas in which to forage for arthropods, lizards, and frogs.

The best method might be to burn several patches of only a few hectares each, scattered throughout the habitat. If the scrub is to be burned on a 10-year cycle, approximately 10% of the total area should be burned each year. By burning several small patches, few territories would be completely burned, and the negative, short-term effects of fire on Scrub Jays would be minimized. In the long term, each territory would consist of a mosaic of shrub thickets 2-3 m tall interspersed with bare ground or patches of short vegetation, and Scrub Jays could be maintained at a relatively high density. This method, requiring a controlled burn every year or two, might require too much time and manpower to be practical in many cases.

In areas that have not been burned for 20 or more years, it may be necessary to clear firebreaks in the scrub to prevent fires from burning out of control. The act of clearing firebreaks should by itself improve the suitability of the habitat for Scrub Jays by providing more open space. In fact, it might be possible to manage Scrub Jay habitat exclusively by mechanical means. Unless the downed vegetation was removed, the threat of fire would remain, however, and the machinery would disrupt the top several inches of soil, with possible negative effects on the plants and other soil organisms. I

cannnot whole-heartedly recommend mechanical clearing of scrub as a general management technique, but it might be valuable in a few special cases. In the discussion of Scrub Jay status in Glades Co. (Chapter 2), I pointed out that some of the scrub on Fish-eating Creek Wildlife Management Area has been cleared for cattle pastures. If the clearing takes place over 8-15 years, and if the scrub is allowed to regenerate without further alterations being made, Scrub Jays might persist in the area, with a bulldozer instead of a fire keeping the scrub from growing too tall and dense. Although the idea may not be aesthetically appealing, it might at least permit the survival of Scrub Jays in an area from which they would otherwise be eliminated.

If firebreaks are necessary, I recommend that they be cleared and maintained to divide the Scrub Jay habitat into tracts of approximately 10-20 hectares. Each tract would contain one or more Scrub Jay territories and could be burned separately, thus creating the desired mosaic effect.

Because of variations in the growth rates of scrub plants, controlled burning programs should ideally be based upon features of the habitat structure, rather than upon a rigid timetable. The density of a given Scrub Jay population is determined primarily by oak density, vegetation height, and amount of bare ground or very short vegetation. In general, scrub should be burned whenever the shrubs average 2-3 m tall. In a scrub with less than 5% bare ground, it might be necessary to burn when the shrubs are 1.0-1.5 m tall, in order to provide sufficient open space to maintain the jay population. In an area with more than 15% bare ground, it might be possible to wait until the shrubs are 3.0-3.5 m tall before burning.

Scrub Jays in Ocala National Forest.--In Ocala National Forest, Scrub Jays are found most frequently in stands that were clearcut from 1971 to 1978 (Table 5). Scrub Jays occupy over half of the stands regenerated from 1975 to 1978. Clear-cutting of the sand pine scrub in Ocala National Forest resembles fire in it effects on Scrub Jays in that all vegetation is cleared, and stands are frequently burned after clearing to destroy any remaining vegetation or fuel. Following clear-cutting, oaks regenerate from roots just as they do after a fire. Depending on local conditions, it takes 3-5 years for the oaks to grow large enough to support a Scrub Jay population. Given that open areas persist and that sand pines do not take over the stand too quickly, Scrub Jays will increase in numbers as the oaks grow taller and taller. (This is due partly to the original colonists reproducing successfully, as well as to more birds colonizing the area.) Vegetation averaging 1 m in height or less will barely sustain a Scrub Jay population (see above). In the stands 5 to 12 years old that are not occupied by Scrub Jays, sand pines are very dense, ranging from 50-80% cover (see above). In many of those same stands, oaks are relatively uncommon. It is possible that the oaks were never common in those stands, thus directly accounting for the absence of Scrub Jays. Once sand pines become dominant, however, they may contribute to a decrease in the abundance and vigor of scrub oaks, also contributing to the absence of Scrub Jays.

Variations in climate, especially rainfall, lead to great variations in the germination rate of sand pine seeds. It has

therefore become standard practice in Ocala National Forest to seed sand pines rather heavily, so that enough seeds will germinate, even in bad years, to produce eventually a high yield of mature sand pines. In areas where few sand pines are present, oaks are generally dense and Scrub Jays are present. High germination rates of sand pine seeds can result in extremely dense stands of sand pines, with few oaks and no jays. If the Forest Service could increase the germination rate of sand pine seeds, more seeds would germinate, possibly reducing the overall suitability of the Forest for Scrub Jays. If, however, the germination rate were increased enough, it should be possible to plant fewer sand pine seeds, and the net effect on Scrub Jays might be negligible.

Coastal scrub.--In the relatively undisturbed areas of Atlantic coastal scrub, Scrub Jays are uncommon or absent. Scrub Jays are no longer residents in St. Johns Co. or in much of Cape Canaveral National Seashore (Volusia Co.), even though long stretches of coastal scrub remain intact. In each of those areas, a solid layer of vegetation is present, with openings only along roads and the beach, and the strip of scrub is narrow, generally only wide enough to permit one Scrub Jay territory between the beach to the east and the coastal hammock to the west. In the 1930's and 1940's, Scrub Jays were fairly common in both of those areas (Grimes 1940, 1943; Longstreet 1954). Scrub Jays are easy to find in some moderately disturbed coastal scrub, such as on the Brevard Co. barrier island from Cape Canaveral to Floridana Beach, although they are absent from more heavily developed areas. My feeling that Scrub Jays are more common in moderately disturbed than in

undisturbed sites is supported by Breininger's (1981) finding that Scrub Jay density is positively correlated with percent open space up to 50% open space.

Under St. Johns Co., I discussed three factors that may have contributed to the decline and eventual disappearance of Scrub Jays from St. Johns Co.: being shot, being hit by speeding cars, and the absence of fire. The same factors probably also apply to Cape Canaveral National Seashore. There is little information about the frequency of fire in coastal scrub, but fires do occur there. Grimes (1932) reported finding a Scrub Jay nest in scrub near Jacksonville Beach that had recently been burned. Also, several acres of scrub north of Ormond Beach, Volusia Co., burned in 1980 or 1981.

It is possible that Scrub Jays were uncommon in all coastal scrub prior to the colonization of Florida by Europeans. Perhaps the jays were restricted to a few areas, such as recently burned sites or blowouts (areas where much sand has blown over the dune crest and covered the vegetation on the inland side of the beachfront dunes), where open space was more common than in undisturbed areas. The jays may have moved every few years as the locations of optimal habitat changed. Scrub Jay densities may have increased in coastal areas as the construction of roads and scattered houses created open spaces surrounded by dense vegetation. This trend would have continued into the 20th century. But as more people moved to Florida, faster cars were built, and roads were paved, things changed. No doubt some jays were shot. The tendency of jays to forage along roadsides probably led to the death of many jays by passing cars. Fire suppression led to the

disappearance of open areas for foraging. Those factors combined to bring about the demise of Scrub Jays in areas where the scrub has been little disturbed.

Competition with Blue Jays.--It has been proposed by some (e.g., Tate and Tate 1982) that Blue Jays (Cyanocitta cristata) are partially responsible for the decline of Scrub Jays, possibly by preventing Scrub Jays from colonizing non-scrub habitats. One might just as well postulate that Scrub Jays prevent Blue Jays from colonizing the scrub. It is true that Scrub Jays vigorously defend their nest sites from trespassing Blue Jays (pers. obs.), an indication that Blue Jays sometimes steal Scrub Jays eggs and nestlings. The converse is also true, however--Scrub Jays sometimes steal Blue Jay eggs (Cox 1983). Westcott (1970) reported that Scrub Jays always dominated Blue Jays in the aggressive encounters he witnessed. I have frequently seen Blue Jays and Scrub Jays within a few meters of each other, but away from nest sites; they have invariably ignored each other. Blue Jays in Florida do not defend territories against conspecifics (Chapter 5), and there is no reason to think that they would behave more aggressively toward Scrub Jays than they do toward other Blue Jays. Furthermore, Blue Jays seem to be rather uncommon in sand pine scrub--the most likely habitat for Scrub Jays to invade--and probably could not keep Scrub Jays from invading that habitat if they wanted to. If competition does occur between Scrub and Blue Jays, it is very subtle.

A parallel case occurs between Scrub Jays and Steller's Jays (Cyanocitta stelleri) in California. Like Blue Jays, Steller's Jays do not defend territories, although each bird dominates other birds near

its own nest (Brown 1963). Although Steller's Jays are, on average, 17% heavier than California Scrub Jays, Scrub Jays generally dominate Steller's Jays in aggressive encounters, except near a Steller's Jay's own nest (Brown 1963; Salata 1982).

All species have certain habitat requirements (James 1970; Partridge 1978); no bird species is found in all Florida habitats. Scrub Jays prefer areas with dense thickets of oak shrubs, and few trees. Blue Jays prefer park-like areas, with groves of large trees interspersed with open areas. Many habitats are suitable for Blue Jays but few are suitable for Scrub Jays. No other natural habitat in Florida even remotely resembles scrub. Scrub Jays do occur in several disturbed, marginal scrub habitats (see below). Habitat choice is determined by both heredity (Partridge 1974) and early experience (Klopfer 1963). I would not expect a bird that had been raised in an area with few or no trees to decide to colonize a forest, even if the plant species were the same in both areas.

Other factors influencing Scrub Jay habitat choice.--Florida Scrub Jays typically nest in shrubs, frequently at the edge of a dense thicket (Woolfenden 1973; pers. obs.). They nest most commonly in oaks, especially in sand live and myrtle oaks (ibid.). When scrub oaks grow in open sunlight, their leaves generally (except during spring leaf fall) form a nearly solid layer on the outside of the plant, giving the plant a neat, rounded appearance. The dense layer of leaves prevents easy detection of the nest. Woolfenden (1973) has written that Scrub Jays may abandon nests that have been exposed by spring leaf fall. Oaks and other shrubs growing under a closed canopy of sand

pines have a different growth form from those growing under full sunlight in open scrub. The oaks have a scragglier appearance, and the leaves rarely form a solid layer on the outside of a plant. Shrubs without an outer protective layer of leaves do not provide suitable nest sites for Scrub Jays. I suspect that the absence of suitable nest sites is an important factor in preventing Scrub Jays from invading sand pine scrub.

In Ocala National Forest, production of acorns--a favorite Scrub Jay food in fall and winter--also decreases somewhat with stand age (Harlow et al. 1980), probably due to increased shading. Acorn production is very high along forest edge (ibid.). Nevertheless, there are some areas where oaks seem sufficiently abundant to support Scrub Jays, but sand pines are dense and jays are absent. Scrub Jays may just have an innate aversion to areas with more than about 50% cover by sand pines. Other tree species probably affect Scrub Jays in the same way that sand pines do, but few tree species are common enough in the scrub to permit even qualitative analysis.

Atypical Scrub Jay habitat.--Before I began the statewide survey of Florida Scrub Jays in 1981, I had a fairly specific idea of what types of habitats I should search for Scrub Jays. Once I began the survey, I was quickly disabused of the notion that Scrub Jays are always found in typical open oak scrub. I have listed in Table 12 some of the sites where I found Scrub Jays in atypical habitats, along with descriptions of the habitats in those places. I found Scrub Jays at each of those sites on at least 2 different occasions, at intervals ranging from several months to 2 years, so I am confident that Scrub

Table 12. Scrub Jay populations in atypical habitats.

County and site number	Habitat description
Alachua Co. 1 = Levy Co. 1	a few clumps of scrub oaks, and scattered turkey oaks, in a pasture
Brevard Co. 14	scattered patches of disturbed scrub at edge of airport
Citrus Co. 2	mostly grass and blackberries, scattered clumps of 1-3 m oaks
Lake Co. 23 = Sumter Co. 1	narrow strip of scrub along SR 48, bordered by pastures and citrus groves
Sumter Co. 2	a few scrub oaks along road, some big trees nearby, otherwise all pasture
Sumter Co. 3	sand live oaks along fence, surrounded by 1-2 m planted slash pines

Jays are resident at all of the sites. Reports of Scrub Jays in the vicinity of Sumter Co. 2 and 3, which appear to be the least suitable sites for Scrub Jays, date back to the 1974 Mabel Breeding Bird Survey. Aerial photographs taken of that area in 1969 indicate that most of the natural habitat along State Highway 469 south of Center Hill had already been cleared by then. Scrub Jays have apparently been using that heavily disturbed habitat for nearly 10 years, and possibly much longer.

All of the sites listed in Table 12 have 3 features in common: the presence of at least a few shrubby oaks; an open canopy; and a fairly large amount of bare ground, or ground covered only by very sparse or short vegetation. Oaks fulfill two requirements of Scrub Jays: 1) they provide nesting sites, as do many species of shrubs; and 2) they provide acorns, a favorite food of Scrub Jays in fall and winter. Although Scrub Jays are frequently found in areas where large trees, especially sand and slash pines, are common, I never found jays in habitats where canopy cover by trees >3 m tall was more than about 50%.

In addition to the habitat types just mentioned, Scrub Jays inhabit several areas that are being developed for houses, apartment complexes, and condominiums. In many of the developments, it appears that virtually all of the native vegetation will be cleared, and it is highly unlikely that Scrub Jays will be able to survive in those areas. In contrast, there are a few areas where development has not yet destroyed all of the scrub, and Scrub Jays persist. One such area is Melbourne Beach (Brevard Co. 14), along Oak Street from 2nd Avenue to

Cherry Drive. Much of the scrub in this area has been cleared for the construction of single-family houses, but several vacant lots remain, with scrub growing on them. Aerial photographs of Melbourne Beach show that scrub accounts for no more than 20-25% of the total area, but Scrub Jays are resident in the area and are not uncommon. The jays are tame and will take peanuts directly from one's outstretched hand, leading me to believe that the jays are fed regularly by the local human residents. Since so little natural vegetation in which jays can forage remains, it is possible that food provided by humans is essential for the continued survival of Scrub Jays there. Scrub Jays inhabit remnant patches of scrub similar to those at Melbourne Beach in several Florida towns and cities, including Boynton Beach, Delray Beach, Cape Canaveral, New Smyrna Beach, and Venice.

It is obvious that development of an area does not automatically lead to the local demise of Scrub Jays, as long as some scrub is left intact. Scrub could easily be left in parks, as a natural fence between houses or between houses and roads or as a hazard on golf courses. Individuals and corporations should be encouraged to leave as much natural vegetation as possible in areas they are developing. Scrub Jays will quickly learn to accept food from humans, and I daresay that most people would enjoy having these attractive birds around. I do not mean to suggest that I support the wholesale development of scrub habitats, or that development will not adversely affect local Scrub Jay populations, but if a portion of scrub is going to be developed anyway, steps can and should be taken to ameliorate the effects of development with respect to Scrub Jays. It would be far

better to have Scrub Jays in an apartment complex or on a golf course than to have no Scrub Jays at all.

Optimal Scrub Jay habitat.--Florida Scrub Jays attain their greatest densities in habitats with the following features: 1) oaks 1-3 m tall covering 50-75% of the area; 2) open space (bare ground or vegetation <15 cm tall) covering 10-30% of the area; and 3) scattered trees, with no more than 20% canopy cover. In such areas, Scrub Jay densities may be well over 40 birds/40 ha, and in some cases may be over 100 birds/40 ha (Breininger 1981). Habitats with those features are usually in disturbed areas, where construction of roads or buildings has created open space next to dense thickets of 2-3 m oaks. In undisturbed areas, it is unusual to find so much open space where the oaks are 2-3 m tall. As oaks grow in height, they also grow in breadth, covering the ground. None of my study sites had been heavily disturbed, none had more than 16% bare ground, and none had a Scrub Jay density >24 birds/40 ha.

In undisturbed habitat, Scrub Jay densities probably would seldom exceed 40 birds/40 ha, even if the habitat were managed specifically for Scrub Jays. Such management would consist of burning relatively small (10-20 ha) patches of scrub whenever the oaks in each patch were 2-3 m tall. Because it is unlikely that any scrub will ever be managed for Scrub Jays only, densities of 20-25 birds/40 ha are probably the maximum that can be obtained in habitat that is managed for the preservation of the scrub but is otherwise undisturbed.

CHAPTER 4
FLORIDA SCRUB JAYS IN A TRANSITORY ENVIRONMENT, OCALA NATIONAL FOREST

In most species of birds, breeding pairs nest alone, without assistance from other birds, but Skutch (1961) listed over 130 species in which breeding pairs were aided in raising their offspring by extra birds of the same or different species. In the intraspecific cases, the extra birds are known as "helpers at the nest," and the species in which they occur are collectively known as cooperative breeders. Currently, about 300 species of birds are known to exhibit some form of cooperative breeding (Emlen and Vehrencamp 1983). In 1961, little was known of the ecological or evolutionary forces that contribute to cooperative breeding in birds. As more and more species were studied, it quickly became apparent that not all species fit the same ecological pattern. Although the greatest proportions of cooperatively breeding species are found in the tropics and subtropics, some species are found in the temperate zones, and cooperative breeders are found across a wide range of habitats (Brown 1978; Emlen and Vehrencamp 1983; and other references therein).

Emlen (1982a; also Emlen and Vehrencamp 1983) has recently proposed an "ecological constraints" model to explain the evolution of cooperative breeding in birds. According to this model, birds serve as helpers whenever ecological constraints prevent them from breeding

successfully on their own. Emlen (1982a) and Emlen and Vehrencamp (1983) listed three types of constraints:

1) Shortage of territory openings. If suitable habitat is saturated with occupied territories, a young bird will have a low probability of finding unoccupied habitat in which to establish its own territory, and may remain with its parents until a breeding space becomes available (Selander 1964; Brown 1974, 1978; Koenig and Pitelka 1981; Emlen 1982a). Habitat saturation has been implicated as a factor in the cooperative breeding systems of several species of birds, including Acorn Woodpeckers (Melanerpes formicivorus, Stacey 1979a; Koenig 1981), Splendid Wrens (Malurus splendens, Rowley 1981), and Florida Scrub Jays (Woolfenden 1975, 1981).

2) Skewed sex ratio. If there are more members of one sex than the other, two or more members of the more common sex may join together with an individual of the opposite sex. In the Superb Blue Wren (Malurus cyaneus), the proportion of birds breeding in groups is directly correlated with the male:female ratio: in years when males greatly outnumber females, the incidence of helpers is high, but when males and females are present in nearly equal numbers, few helpers are found (Rowley 1965; Emlen 1978).

3) Unpredictable, sometimes harsh environments. Pairs of White-throated Bee Eaters (Merops bullockoides) can breed successfully in years of high rainfall, when the insects they feed their young are abundant. In years of low rainfall, pairs cannot always find sufficient food for their nestlings, and larger groups form for breeding (Emlen 1982a). Brown (MS) has pointed out, however, that an

erratic environment does not directly cause birds to form groups for breeding. For the bee eaters, the crucial factor is a food supply (insects) that sometimes falls below the level at which unaided pairs can breed successfully. Birds in any environment where food is scarce might have to form groups for breeding, regardless of environmental variability or predictability.

For the first group of birds, if habitat saturation is indeed a driving force in their sociality, one would expect group sizes to be smaller in areas where some habitat is unoccupied than in areas where the habitat is completely saturated (Stacey 1979; Emlen 1982a). This prediction has been tested so far for only one species--the Acorn Woodpecker. The degree of habitat saturation for Acorn Woodpeckers decreases as one moves from a site in California, to sites in Arizona and New Mexico, and to another site in Arizona (MacRoberts and MacRoberts 1976; Stacey and Bock 1978; Stacey 1979; Trail 1980). As habitats become less saturated, the proportion of territories vacant each year increases, and mean group size and the proportion of breeding groups with helpers both decrease.

Florida Scrub Jays at Archbold Biological Station (ABS), Highlands Co., Florida, and Ocala National Forest (ONF), Marion Co., Florida, provide another test of the habitat saturation hypothesis. At ABS, habitat is saturated, and breeding opportunities are scarce, whereas in ONF, the amount of habitat is increasing, so breeding opportunities should be more frequent, and groups should be smaller. In ONF, Scrub Jays also have a means of breeding territory acquisition that has previously been reported for only two other species--the opportunity to colonize newly-created habitat.

Procedures

As part of the statewide survey of Florida Scrub Jays, I searched the more accessible portions of ONF for jays in 1980 through 1983. Ages of the stands occupied by Scrub Jays were obtained from the U.S. Forest Service.

In August of 1982 and 1983, I visited several stands of different ages to count the numbers of jays present in different groups. Juvenile Scrub Jays can be easily distinguished from adults by their brownish heads. The blue-headed adult plumage is attained through the first pre-basic molt, beginning as early as June (Bancroft and Woolfenden 1982). In August, juveniles still retain at least some brown feathers on their heads, so the numbers of adults and young-of-the-year can be counted easily. In addition, juveniles are able to feed independently of their parents by August, but all group members still forage together, and they can be attracted for counting by playback of the "screech scold" predator alarm call (Barbour 1977).

Woolfenden (1975) measured reproductive success of Scrub Jays by the number of "independent young" (those surviving to their first August) per group, so my data are directly comparable to his.

Numbers of adults and juveniles in different groups at ABS in August of 1982 and 1983 were generously provided by Glen E. Woolfenden.

Results

In Ocala National Forest, a significantly greater proportion of stands regenerated from 1972 through 1978 (43%) is occupied by Scrub Jays than of stands regenerated from 1965 to 1971 (22%, chi-square = 2.825, $P<0.01$; Table 13).

Table 13. Number of stands occupied by Scrub Jays in each year-class in Ocala National Forest.

Year	occupied stands	total stands	proportion occupied	total area (ha)
1979-81	4	99	0.04	7200
1978	9	17	0.53	2400
1977	2	3	0.67	2280
1976	8	22	0.36	1380
1975	13	18	0.72	1380
1974	1	7	0.14	1380
1973	8	24	0.33	1380
1972	4	14	0.29	1380
1971	9	24	0.38	1380
1970	2	14	0.14	1380
1969	1	5	0.20	1380
1968	0	10	0.00	1380
1967	2	8	0.25	1380
1966	0	2	0.00	1380
1965	1	4	0.25	1380
Total	64	271	0.24	

The numbers of Scrub Jay groups of different sizes in Ocala National Forest and Archbold Biological Station in 1982 and 1983 are shown in Table 14. I found no groups in ONF with more than 4 birds, although groups of such size are not uncommon at ABS (Woolfenden 1981).

In Ocala National Forest in 1982, groups averaged 2.60 adults (Table 15). In 1983 mean group size was 2.31 adults; the difference is not quite significant ($P=0.0513$; this and following significance levels obtained from Mann-Whitney U test). In 1982, group sizes at ONF and ABS were almost identical; in 1983, groups were significantly larger at ABS ($P<0.01$; Table 15). For both years combined, group sizes were somewhat larger at ABS than in ONF (Table 16); the difference is not quite significant ($P=0.07$). Scrub Jay breeding groups at ABS from 1969 to 1978 averaged 2.97 birds per group--significantly greater than the group size at ONF for 1982, for 1983, and for both years combined ($P<0.001$).

I also calculated "typical group size" (size of group in which the average animal lives; Jarman 1974) for ONF and ABS in both years. For ONF in 1982, typical group size was 2.7 birds; for ONF in 1983, it was 2.4 birds; for ABS in 1982, 2.8 birds; and for ABS in 1983, 3.0 birds. For both years combined, typical group size was 2.6 birds in ONF and 2.9 birds at ABS. The data used to calculate typical group size are the group sizes of each individual animal, rather than the size of each group, so large groups contribute more to the figure than do small groups. Because the data are not independent, statistical tests are not appropriate, but typical group sizes in ONF were consistently smaller than those at ABS.

Table 14. Numbers of Scrub Jay groups of different sizes at Ocala National Forest and Archbold Biological Station.

Group size	ONF 1982	ONF 1983	ABS 1982	ABS 1983	ABS 1969-1978*
2	29 (56%)	35 (71%0	19 (68%)	13 (43%)	125 (47%)
3	15 (29%)	13 (27%)	4 (14%)	10 (33%)	63 (24%)
4	8 (15%)	1 (2%)	4 (14%)	7 (23%)	50 (19%)
5	0	0	1 (4%)	0	18 (7%)
6-8	0	0	0	0	10 (4%)

*from Woolfenden (1981, Table 16-3)

Table 15. Number of adult-plumaged Scrub Jays per group, Ocala National Forest and Archbold Biological Station, 1982 and 1983. *, $P<0.05$; no other pairwise comparisons are significant.

	1982	1983
Ocala N. F.	$\bar{X}$ = 2.60	$\bar{X}$ = 2.31*
	s = 0.748	s = 0.508
	n = 52	n = 49
Archbold B.S.	$\bar{X}$ = 2.54	$\bar{X}$ = 2.80*
	s = 0.881	s = 0.805
	n = 28	n = 30

Table 16. Average sizes of Scrub Jay groups, Ocala National Forest and Archbold Biological Station, 1969-78 and 1982-83. *, means different at P=0.07; #, means different at P<0.001.

	1982-1983	1969-1978
Ocala N. F.	$\bar{X}$ = 2.46*#	
	s = 0.656	
	n = 101	
Archbold B. S.	$\bar{X}$ = 2.67*	$\bar{X}$ = 2.97#
	s = 0.846	s = 1.127
	n = 58	n = 266

There was no correlation ($r = 0.029$, ns, $n = 95$) between stand age and group size in ONF.

I measured reproductive success of Scrub Jay groups in ONF in August of 1982 and 1983 by counting the number of juveniles and adult-plumaged birds in different groups. There were no significant differences in reproductive success between the two years, so I have pooled the data. For both years combined, there was no indication that having helpers in a group significantly increased reproductive success (Table 17), either in mean number of juveniles per group in August, or in probability of raising any young at all.

Discussion

Territory acquisition

The Florida Scrub Jays of Archbold Biological Station constitute one of the best-known populations of birds anywhere in the world. As discussed in the introduction to this dissertation, Glen Woolfenden, John Fitzpatrick, and their colleagues have been studying the Archbold Scrub Jays since 1969 (Barbour 1977; DeGange 1976; Stallcup and Woolfenden 1978; Woolfenden 1973, 1975, 1976, 1978b, 1981; Woolfenden and Fitzpatrick 1977, 1978). Young Scrub Jays rarely breed on their own when they first become physiologically mature (age one year, Stallcup and Woolfenden 1978; Woolfenden 1981); instead, they remain with their parents for up to 5 years and assist in raising their younger siblings. Woolfenden (1975, 1981) has proposed habitat saturation as a major factor in this cooperative breeding system.

Table 17. Reproductive success of Scrub Jay groups with and without helpers, Ocala National Forest, 1982 and 1983 combined. No significant differences between groups with and without helpers.

	Juveniles per group	% of groups successful
Helpers present	$\bar{X}$ = 0.97 s = 1.093 n = 37	59.5%
Helpers absent	$\bar{X}$ = 0.88 s = 1.031 n = 64	51.6%

Young Scrub Jays at ABS have two ways to enter the breeding population: one is to wait for an established breeder to die and take over his or her place in the population; that option is open to males and females. Males have the additional option of staying at home and eventually claiming part of the parent's territory in the following manner: Breeding pairs with helpers raise more young than pairs without helpers, so the helpers increase group size. As a family group grows numerically, the territory enlarges until the dominant male helper claims part of his parent's territory for his own breeding territory and takes as a mate a female from outside the family group. This method of territory acquisition is best referred to as "territorial budding" (Woolfenden and Fitzpatrick 1978). (The term "territorial inheritance" is frequently applied to Florida Scrub Jays, but since the death of a male breeder is not a prerequisite for his son's acquisition of a territory, and since sons usually do not breed in the same territories as their fathers, "territorial budding" is a more appropriate term.) It is not clear whether the opportunity for territorial budding to occur is purely a mechanical response to the increase in group size and resultant increase in territory size, or whether male helpers work to increase the territory size beyond that which would occur naturally as a result of increased group size. Territorial budding also provides breeding opportunities for females. The young birds are believed to remain at home and help their parents because they cannot survive and breed elsewhere. Females disperse to other territories to breed, so they rarely help for more than 2 years. Males have the option of claiming part of their parents' territory, so they may help for as much as 5 years (Woolfenden and Fitzpatrick 1978).

Florida Scrub Jays inhabit oak scrub (= "scrubby flatwoods" of Woolfenden 1973), a shrubby community dominated by 3 or 4 species of largely evergreen oaks, generally no more than head high (Chapter 3). During my survey of Scrub Jay distribution, I found no habitat in Highlands Co. that was suitable for Scrub Jays and not occupied by them. In addition, development of citrus groves and housing in Highlands Co. has resulted in the clearing of perhaps 60% of the scrub around ABS (Chapter 2). This suggests that territorial budding might have been less important in the past than it is now. Prior to the development of Highlands Co., the scrub may have been much less saturated with Scrub Jays than it is today.

The scrub in and around Woolfenden's study tract has burned periodically for many years (J. N. Layne, pers. comm.). Although parts of that scrub are unsuitable as Scrub Jay habitat, the scrub as a whole provides very stable habitat for Scrub Jays. Fires prevent the scrub from growing too tall and dense for Scrub Jays. Territory boundaries may expand or contract as a group gains or loses members, but locations of territories change little from year to year (Woolfenden 1975). Furthermore, although reproductive success and the number of juveniles present are annually quite variable, the density of adults remained remarkably constant at just over 10 birds/40 ha from 1971 to 1979 (Woolfenden and Fitzpatrick MS).

Ocala National Forest contains the world's largest stand of sand pine, Pinus clausa, in a habitat known as sand pine scrub. The species composition of sand pine scrub is essentially the same as that of oak

scrub at ABS, but sand pine scrub is dominated by a layer of sand pine trees 12-15 m tall. Trees over 3 m tall are sparsely scattered in the ABS oak scrub.

Sand pine is harvested for pulpwood. The pines are harvested by clear-cutting, then the site is prepared and reseeded with sand pine seeds. Scrub oaks and palmettoes, which form most of the understory of the mature forest, resprout quickly from roots following clearing. Within 3-5 years, the oaks are 1-2 m tall, and if dense enough create habitat suitable for Scrub Jays, which may then colonize the area. Within several months after being sown, sand pine seeds begin to sprout, and seedlings and saplings frequently grow over half a meter in height a year. As long as the pines are less than 3 meters tall, or if they are not very dense (less than about 50% cover, Chapter 3), the pines do not seem to affect the Scrub Jays. But if the pines in a stand are much above 3 m tall, and if they are fairly dense, they may form a closed canopy, diminishing the suitability of that stand for Scrub Jays. While one stand is growing too old, however, new stands are being created and are going through the same cycle, continually providing new habitat for Scrub Jays to colonize.

Stands 5-10 years old represent ideal Scrub Jay habitat. Beyond 10 years in age, stands frequently contain tall, dense sand pines, and few of those stands support Scrub Jays (Table 13). I found Scrub Jays in only one stand dating from before 1965, and that stand had no sand pines. I believe that some of the older stands formerly supported Scrub Jays, but as the habitat succeeded from open oak scrub to sand pine forest, the jays disappeared.

The opportunity for "helpers at the nest" to disperse to habitat newly created by disturbance (in this case, clear-cutting) has been previously reported for only two other cooperatively breeding birds, the Brown Jay (Cyanocorax morio; Lawton and Lawton MS) and the Splendid Wren (Rowley 1981). Splendid Wrens occasionally disperse to habitat that is regenerating after being burned a few years previously, but apparently this is an uncommon event (Rowley 1981). At Monteverde, Costa Rica, new habitat for Brown Jays is being created by clearing of the forests (Lawton and Lawton MS). Brown Jays occupy disturbed habitats throughout their range (Skutch 1935; Selander 1959; Lawton and Guindon 1981), so dispersal to new habitat may be a regular event for them. Brown Jays are discussed in more detail in Chapter 6.

I would like to emphasize that the movement of Scrub Jays from site to site in ONF is not a strictly recent phenomenon. Although clear-cutting was not extensive in the sand pine scrub in ONF prior to the 1960's, fire has been around for a long time. Before the U.S. Forest Service began an active program of fire suppression in ONF, fires apparently occurred in sand pines every 30-60 years (Christensen 1981). The U.S. Forest Service currently plans to clearcut the sand pines on a 50-year rotation (U.S. Forest Service 1972). When fires do occur in sand pines, they generally kill all vegetation. There is one major difference between fires and clear-cutting: sand pines appear to regenerate more slowly after a fire than after clear-cutting. Following a fire, the scrub would have been suitable for Scrub Jays for a longer time than following clear-cutting. But eventually, the sand pines would have grown up too tall anyway, and Scrub Jays would have moved on to a more recently burned area.

This cycle of events probably is not restricted to ONF, but is typical of sand pine scrub throughout Florida. In the Big Scrub, southwest of Ocala, Marion Co., Florida, Scrub Jays currently inhabit an area of 600 ha that was burned in 1977. Most of the rest of the Big Scrub is mature sand pine scrub, not inhabited by Scrub Jays. Examination of aerial photographs taken at 8-10 year intervals dating back to the 1930's suggests that fires have periodically burned different portions of the Big Scrub. Scrub Jays presumably have moved from site to site, following the fires.

There is little information on the exact locations of breeding Scrub Jays in ONF before this study, but there are some descriptions of the habitat. In 1892-1897, Webber (1935) visited the area that is now Ocala National Forest. He reported that large sand pines "were the most conspicuous feature of the flora, their finely branched bushy tops dominating all over the main part of the scrub" (p. 357). Whitney (1898), however, examined scrub near Altoona, on the southern edge of the forest, and wrote that the scrub was "about the height of a man's head" (p. 15). He added that the scrub extended unbroken for 10-15 miles north of Altoona. Webber and Whitney apparently did not visit the same areas. Whitney's (1898) area probably had been burned a few years previously. His description and a photograph (Plate VI) suggest that the scrub north of Altoona could have supported numerous Scrub Jays. In 1923, Scrub Jays were "abundant" in eastern Marion Co., where ONF is located (Byrd 1927). Webber (1935) visited the Forest again in 1932, and was able to make direct comparisons of the habitat across a 40-year time span. "Now it is only here and there in the great extent

of the scrub that one sees a small patch of large trees, which through some accident have escaped the destruction of the fires . . . . The young pines are common all over the area even now, but the oaks dominate the vision" (Webber 1935: p. 357). Several photographs accompanying the article illustrate what appears to be ideal Scrub Jay habitat, dominated by oaks about 1 m tall. A wildfire in 1935 burned 35,000 acres of ONF (Snedaker and Lugo 1972). In the absence of sand pines, Scrub Jays must have been quite common in ONF during at least the 1920's and 1930's.

As the U.S. Forest Service became more active in fire suppression, more and more of the Forest was able to mature into merchantable stands of sand pine (Cooper et al. 1959), presumably with a concommitant decline in the numbers of Scrub Jays. By the late 1960's, Westcott (1970) was able to find nesting Scrub Jays in only a few parts of ONF, and they were numerous only along the southern edge of the Forest.

I found Scrub Jays in 61 areas scattered throughout ONF, but in only one stand dating from before 1965, and in only four stands dating from 1965-1969 (Table 13). The jays in the younger stands must have come from older stands. Although population growth surely accounts for occupation of some of the stands, I find it difficult to believe that any Scrub Jay population could increase 12-fold in 10 years. Using natality and mortality data presented in Woolfenden (1975), Emlen (1978), and Stallcup and Woolfenden (1978), I crudely calculated r_{max} for Florida Scrub Jays to be 0.14. I assumed annual survivorship of Scrub Jays to be 0.37 for birds in their first year and 0.88 for birds older than one year. I assumed the number of female

offspring produced per female per year to be 0.3 for one-year olds, 0.5 for 2-year olds, 0.8 for 3-year olds, and 1.1 for birds older than 3 years. These are liberal figures, assuming all benefits of group living with none of the costs, so the actual r_{max} is probably somewhat lower. Even if $r_{max} = 0.14$, a population could increase by a factor of only 8.2 in 15 years, hardly sufficient to account for the spread of Scrub Jays from four stands in 1969 to 64 stands in 1983. I conclude that some of the jays were born in areas where jays are no longer present.

Scrub Jay habitat in Ocala National Forest forms a constantly changing pattern of suitable patches surrounded by unsuitable habitat. There are thus two factors that contribute to Scrub Jay dispersal in the Forest: 1) new habitat is continually being created as a result of clear-cutting; and 2) older stands become unsuitable for Scrub Jays, which abandon some of those stands. As a result, Scrub Jays have, in the first case, the opportunity for dispersal, and in the second, the need to disperse. In some cases, groups can simply move into adjacent, younger stands--that seems to happen fairly frequently. I found several places in ONF where a clearcut stand was regenerating adjacent to another stand already occupied by Scrub Jays. In all cases, it appeared that the jays began to colonize the younger stand as soon as the oaks in it were approximately 1 m tall. Isolated stands have to be colonized by birds from more distant areas, although no information is available on how far Scrub Jays will disperse to colonize unoccupied habitat, or on whether the jays disperse as individuals or in groups. Groups might have a better chance than individuals of claiming and

defending territories, as has been suggested for Green Woodhoopoes (Phoeniculus purpureus, Ligon and Ligon 1983). In general, it may be that the first birds to colonize an area stay there until they die, and most or all of their offspring leave as soon as they can find their own breeding space, frequently by dispersing to a younger stand. Territorial budding may occur sometimes, but I suspect that it is relatively infrequent. It is probably not necessary for a jay to remain at home the 3 or 4 years that are sometimes necessary for the territory to grow large enough for it to be subdivided, and by the time a jay is old enough to claim part of the territory, the habitat may no longer be suitable.

The physiognomy of the scrub in ONF is profoundly different from that at ABS, as a result of a different burn frequency. Sand pines cannot survive and reproduce in an area where fires occur more frequently than every 10-15 years, such as at ABS. In ONF, with a natural fire frequency of 30-60 years, sand pines can mature and produce large numbers of seeds between fires. When a fire does occur in mature sand pine scrub, it is generally a hot crown fire that kills and chars all above-ground vegetation. At ABS, there is less time for litter and fuel to accumulate between fires, so fires there are not as hot and may leave some areas completely unburned.

Prior to about 5000 years ago, some sort of oak-dominated xeric habitat--possibly scrub--was much more widespread in Florida than scrub is at present (Watts 1980). In addition, Scrub Jay fossils from the late Pleistocene have been found in three different areas, each of which is at least 10 miles from the nearest known historical population

of Scrub Jays (Brodkorb 1959; Hamon 1964; Ligon 1965). So, at least at some time in the past, Scrub Jays have been more widespread, and perhaps their habitat was not as saturated as it is now. Territorial budding--but probably not retention of non-breeding birds in the natal territory--may have become important only in the past 5000 years in response to decreasing habitat availability.

Group size

Through the 1950's, there was little demand for sand pines. As demand for sand pines increased in the 1960's, so did the number of acres of sand pines harvested each year in Ocala National Forest. There has been another increase in the past 5 years (Table 13), so the amount of Scrub Jay habitat is increasing, and the opportunities for jays to disperse and breed on their own should likewise be increasing.

If territorial budding were a common means of territory acquisition in ONF, one might expect to find a correlation between stand age and group size. If new habitat is colonized by dispersing individuals, and their offspring are retained for 2-5 years in the parents' territory, one would expect that older stands would contain groups that had been residents there for longer periods of time than groups in younger stands. If birds must wait to claim part of their natal territory for breeding space, then older groups should be larger than younger groups.

The absence of a correlation between stand age and group size may result from either of two factors: 1) Scrub Jays sometimes disperse in groups, at least by moving into younger stands adjacent to their

current territories; or 2) the offspring leave as soon as they can, frequently by moving to new habitat on their own. I suspect that both factors are in effect.

In at least some years, and possibly in most years, groups are smaller in Ocala National Forest than at Archbold Biological Station (Tables 14-16). The differences between typical group sizes at the two sites are greater than those for mean group sizes, because large groups are weighted more heavily in the calculations for typical group size. The groups in ONF do consist of parents and their offspring of previous years. I infer from the smaller group sizes in ONF that birds there do not have to remain on their natal territories as long as they do at ABS before they are able to find their own breeding territories. I do not know whether the "helpers" bring food to nestlings and fledglings, but they do assist in defending the nest against potential predators and the territory against intruding Scrub Jay neighbors.

It is possible that the lower mean group size in ONF is only temporary. The acreage of sand pines cut each year increased in 1977 and 1978 and has since stabilized. Because it takes 3-5 years following clearing for suitable Scrub Jay habitat to develop on a given site, there is a delay in the response of group sizes to habitat availability. When the amount of habitat available stabilizes in a few years, group size may increase.

The absence of any correlation between group size and reproductive success (Table 17) does not necessarily mean that helpers are not of any benefit--even if they do not increase reproductive success as measured by number of juveniles in August, they may still contribute to

increased survivorship of younger birds after their first August, or, by reducing the work load of their parents, they may increase the survivorship of their parents (Stallcup and Woolfenden 1978). On the other hand, Scrub Jays in Ocala National Forest may not help much. Yearling jays at ABS are almost invariably helpers (Stallcup and Woolfenden 1978; Woolfenden 1981). They are included in measures of group size, but they provide less food to nestlings than do older helpers (Stallcup and Woolfenden 1978). In years when group sizes are small in ONF, it is likely that most of the extra birds (those in addition to the breeding pair) in each group are yearlings. Furthermore, if helpers disperse at earlier ages in ONF than at ABS, there will be a greater proportion of experienced breeders without helpers in ONF than at ABS. Experienced breeders show greater reproductive success than novice breeders (Woolfenden 1975). Scrub Jay pairs without helpers in ONF produce somewhat more independent young (those surviving to their first August; Woolfenden 1975) per season than those at ABS (0.9 young in ONF vs. 0.5 young at ABS), and pairs with helpers in ONF produce somewhat fewer young than those at ABS (1.0 in ONF vs. 1.3 at ABS) (ONF data from Table 17, ABS data from Woolfenden 1975). At the very least, these data are consistent with the suggestions that breeding pairs without helpers are more experienced in ONF than at ABS--pairs are without helpers because young have dispersed, rather than the lack of previous breeding--and that helpers are on average younger and less helpful in ONF than at ABS.

At Archbold Biological Station, Scrub Jays remain as helpers, on their natal territories, because they have no other choice. In Ocala National Forest, Scrub Jays also inhabit almost all suitable habitat. But, new habitat is continually being created, so young birds do not have to wait for established breeders to die before they can find a place to breed on their own, or wait to claim some of their parents' territory. My data support the hypothesis that ecological saturation is an important factor in the cooperative breeding system of Florida Scrub Jays. Where more habitat is available, fewer Scrub Jays are found as helpers.

CHAPTER 5
BEHAVIORAL ECOLOGY OF BLUE JAYS IN FLORIDA

Blue Jays (Cyanocitta cristata) are common and widespread in temperate woodlands in eastern North America. In spite of (or perhaps because of) their abundance, they have not attracted the attention of many scientists. Prior to the late 1970's, only one study had been made of the ecology and behavior of Blue Jays (Hardy 1961). In the late 1970's, several studies were initiated into the behavioral ecology of Blue Jays (Hilton and Vesall 1980; Laine 1981; Gross 1982; Racine and Thompson 1983), some of them stimulated by the recent widepsread interest in cooperative breeding by New World jays. The work presented here was based on a population of Blue Jays in Gainesville, Florida, and represents the first study of Blue Jays south of Pennsylvania and Kansas. I was concerned primarily with answering two questions that are germane to later parts of this dissertation: 1) Do Blue Jays in Florida have helpers at the nest? and 2) Do they defend territories of exclusive use?

Procedures

The study was conducted in and around Corry Village, an apartment complex on the west edge of the campus of the University of Florida, Gainesville, Alachua Co., Florida. The habitat is a mixture of woodlots, open space, and buildings. Corry Village covers an area of

about 8 ha; most of my observation time was spent in this area, although I frequently visited surrounding areas to determine the limits of home ranges of birds residing primarily at Corry Village. The Corry Village jays are accustomed to humans and can be watched from a few meters distance without their being disturbed.

Observations of Blue Jays were made primarily from May-August of 1982 and May-June of 1983, although I occasionally looked for birds in the intervening months. Blue Jays were captured in baited traps and banded with unique combinations of colored plastic leg streamers or bands. Some recently fledged jays, incapable of sustained flight, were captured by hand on or near the ground. I banded 24 adult and 11 juvenile Blue Jays.

In the following discussion and the tables and figures, individual jays are identified by their leg band or streamer combinations, using the following color abbreviations: W, white; Y, yellow; Dg, dayglo orange; G, green; B, black. A few birds received only one streamer and are identified by the color of that streamer (e.g., "Red," "White," "Black," "Yellow"). Codes of birds with leg bands begin with the prefix "b"; birds with streamers have no prefix.

I concentrated my efforts on finding nests and watching them during the nestling period. I tried to watch nests with nestlings for at least an hour a day for several days in order to determine how many birds were feeding the young.

I also walked through the study area at different times of day, recording locations and activities of all Blue Jays I saw.

Results

I made observations totalling over 2 hr at each of 10 Blue Jay nests (Table 18). Six of the nests represented attempts at raising first broods, four represented attempts at second broods. At nine of the nests, with a combined total of 2738 min of observation time, there was no indication that more than one pair of adults was attending the nest. This was true for the attempts at second broods, for which juveniles from first broods might have fed their younger siblings. This was also true for one nest (83-5) in 1983, for which 2 young raised by the parents in 1982 remained in the Corry Village area.

I made less frequent observations at 6 additional nests. At none of them was there any indication that more than 2 adults were present. Occasionally, another Blue Jay would approach a nest and look into it. If one of the nest owners was present, that bird would invariably chase off the intruder. Otherwise, the intruder would inspect the nest for a few seconds and then move on. None of the intruders ever showed any signs of parental behavior at any of these nests.

Only females were seen to incubate and brood; males and females regularly fed nestlings and fledglings, although there was considerable individual variation in rates of feeding. These data conform to the general patterns of jay behavior (Goodwin 1976).

Table 18. Behavior of Blue Jays at frequently watched nests.

Nest	Male	Female	Brood number, success[c]	Observation time	feedings during watches male	feedings during watches female	feedings during spot checks male	feedings during spot checks female
82-1	Y	Dg	1 +	269 min	17	19	7	14
82-4[a]	unb.	R-Dg	1 ?	134 min	2	5	2	-
82-7[a]	unb.	G-W	1 ?	403 min	29	31	-	2
82-10[b]	W-Dg	Red	2 -	185 min	-	-	-	-
82-13	Y-Dg	W-Dg	2 +	603 min	7	3	17	2
82-17	W-Dg	Red	2 +	169 min	6	3	8	5
82-20	W-W, W-Y	bRW	see text and Table 19					
83-3	W-Y	bRW	1 +	249 min	5-7	3-5	5	-
83-4	Y-Dg	B-Dg	1 +	241 min	20	9	1	1
83-5	W-Dg	Red	1 +	485 min	23	11	3	1

[a]determination of sexes not certain

[b]nest failed about time eggs hatched

[c]brood number is not the same as clutch number unless young fledged from all previous clutches; + = nest successful; - = nest unsuccessful

One nest, 82-20, was an exception. This nest was regularly attended by 2 males and one female (Table 19). Only the female, bRW, was seen brooding at 82-20. Male W-Y fed the nestlings and fledglings most frequently, followed by male W-W, then by bRW.

Blue Jays in Florida do not defend territories of exclusive use. Quite to the contrary, they have broadly overlapping home ranges. Figures 27-30 show the home ranges of different pairs (and one trio) of Blue Jays in 1982 and 1983. Overlap of home ranges of individual birds in 1982 and 1983 is illustrated in Figures 31 and 32, respectively. Birds would chase intruders away from their own nests, but I lack sufficient data to determine how far from a nest each bird's zone of dominance extended. I could not tell, for instance, whether Blue Jays have "concentric circles of diminishing dominance," as Brown (1963b) reported for Steller's Jays (Cyanocitta stelleri) in California. The only overt aggression I witnessed was near nests and at one bird feeder in the study area.

Discussion

A "helper at the nest" was seen at only one of the 16 Blue Jay nests that I watched with any regularity, so cooperative breeding is not typical of Blue Jays at Gainesville, Florida. Two lines of evidence indicate that the events at nest 82-20 were unusual for Blue Jays. First and foremost, W-W and W-Y fought with each other on 9 of the 10 occasions when they were present at the nest simultaneously. In the 6 cases in which a winner could be determined, it was always W-W, either by displacing W-Y or driving him completely away. Second,

Table 19. Parental behavior observed at Blue Jay nest 82-20.

Nestling stage: 943 min observation time plus 10 spot checks

	W-Y(male)	W-W(male)	bRW(female)
definite feedings of nestlings	24	15	7
possible/probable feedings	15	10	9
other visits	7	7	20
minutes at nest	58	24	356

Fledgling stage: 148 min observation time plus 7 spot checks

definite feedings	16	7	3
possible/probable feedings	2	1	0
total definite feedings of nestlings and fledglings	40	22	10

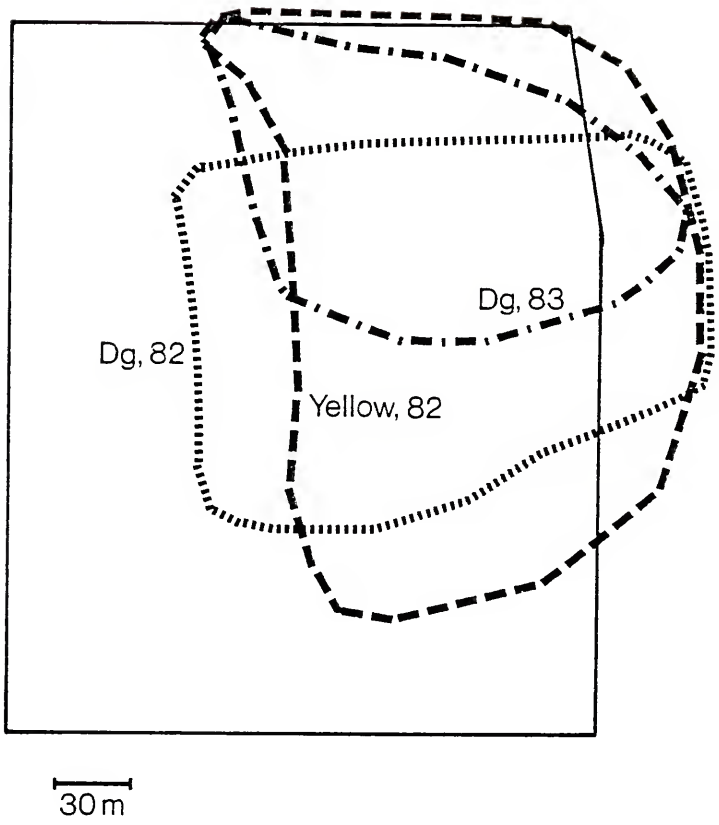

Figure 27. Home ranges of Blue Jays Dg and Yellow, Corry Village, May-July, 1982 and 1983. Solid line represents boundary of Corry Village.

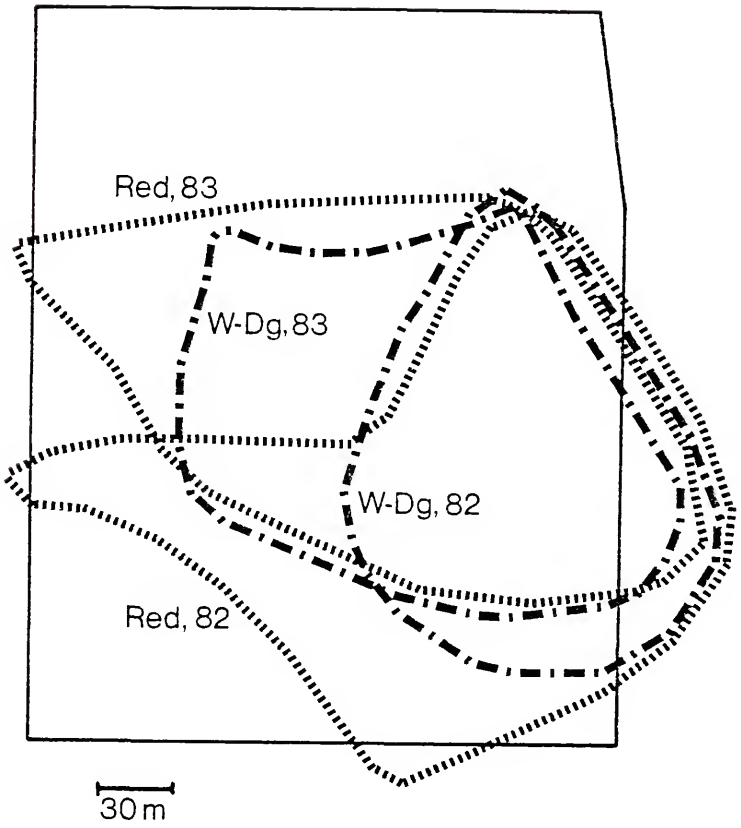

Figure 28. Home ranges of Blue Jays Red and W-Dg, Corry Village, May-July, 1982 and 1983. Solid line represents boundary of Corry Village.

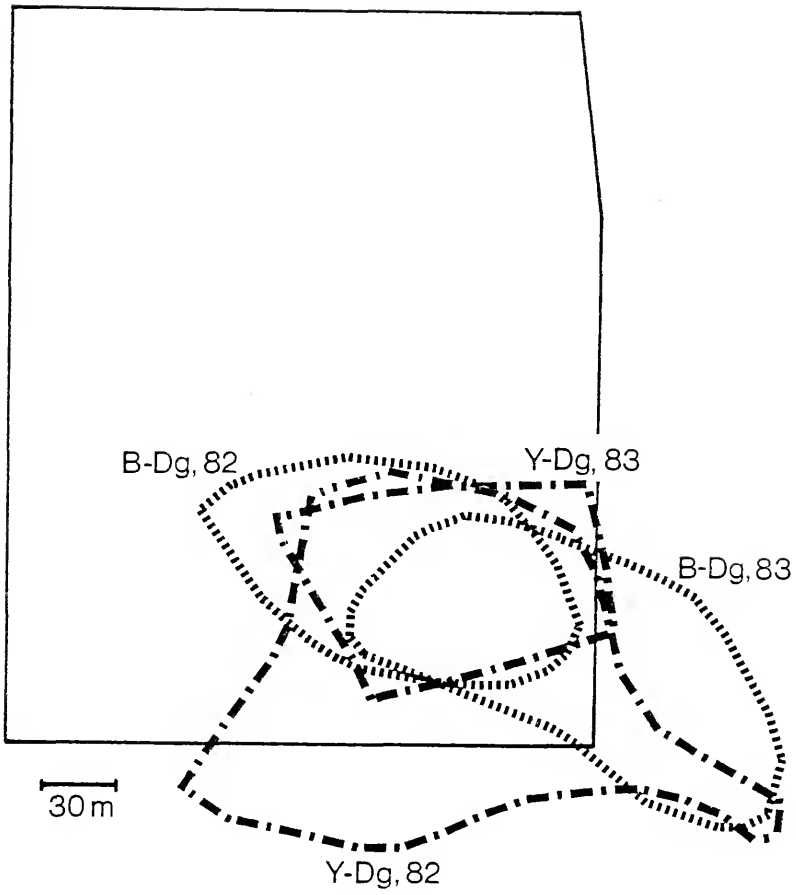

Figure 29. Home ranges of Blue Jays B-Dg and Y-Dg, Corry Village, May-July, 1982 and 1983. Solid line represents boundary of Corry Village.

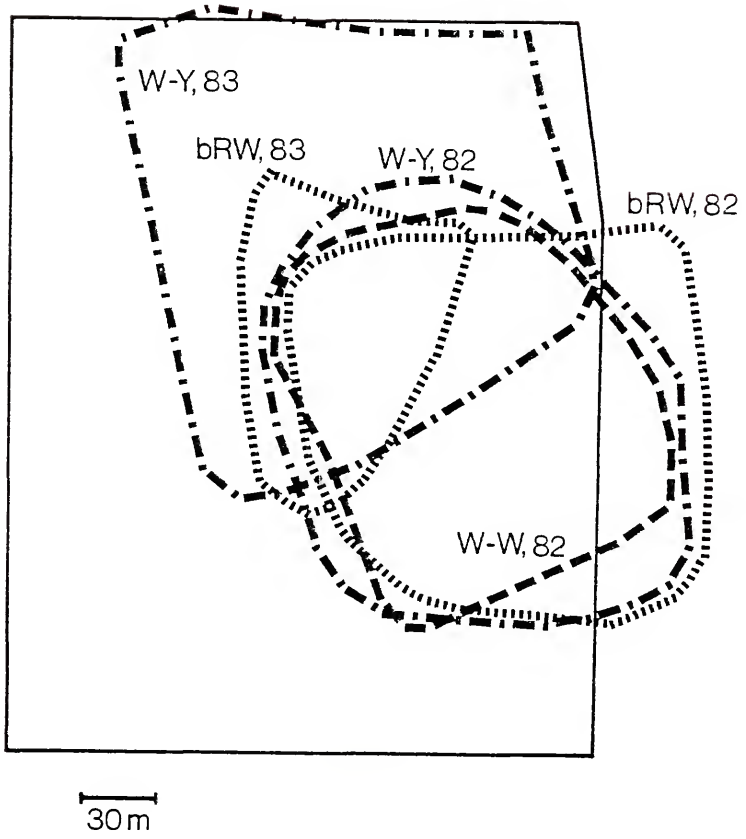

Figure 30. Home ranges of Blue Jays bRW, W-W, and W-Y, Corry Village, May-July, 1982 and 1983. Solid line represents boundary of Corry Village.

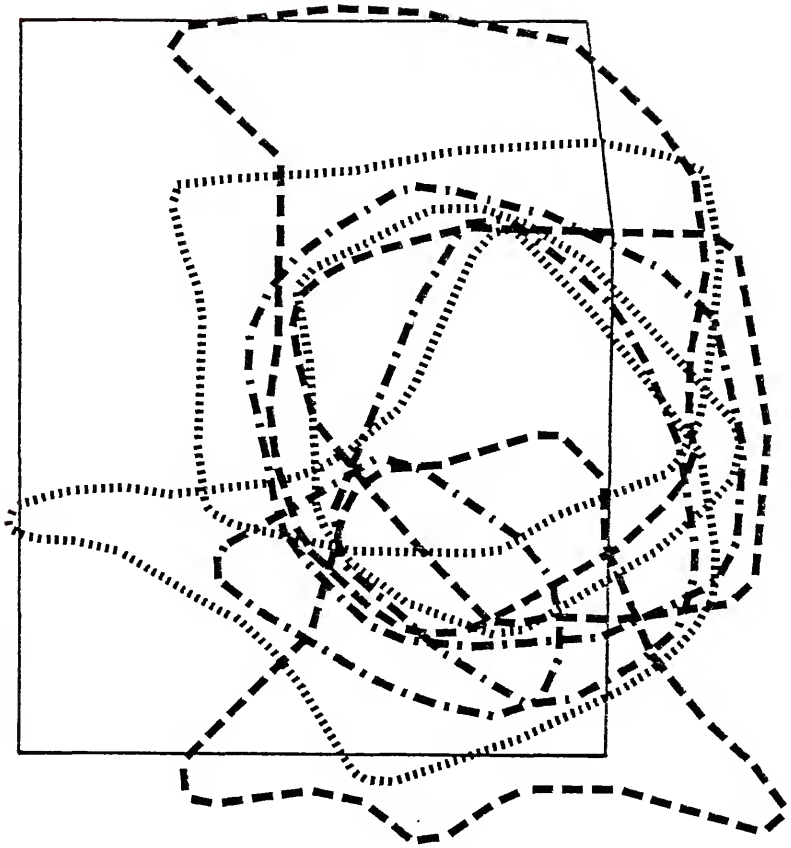

Figure 31. Overlap of home ranges of nine color-marked Blue Jays (Dg, Yellow, Red, W-Dg, B-Dg, Y-Dg, bRW, W-W, W-Y) at Corry Village, May-July, 1982. Individual home ranges are identified in Figures 27-30. Solid line represents boundary of Corry Village.

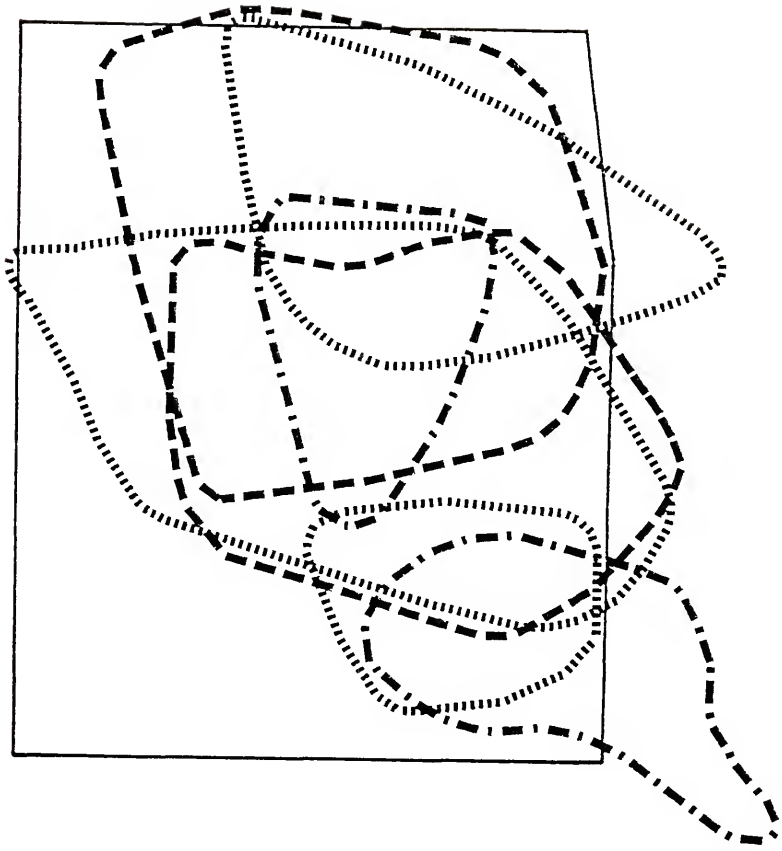

Figure 32. Overlap of home ranges of seven color-marked Blue Jays (Dg, Red, W-Dg, B-Dg, Y-Dg, bRW, W-Y) at Corry Village, May-July, 1983. Individual home ranges are identified in Figures 27-30. Solid line represents the boundary of Corry Village.

bRW begged both males, and was probably fed by both of them. Male Blue Jays commonly feed their mates at or away from the nest. Mate feeding is frequently preceded by begging and wing-fluttering by the female, although such behavior does not always result in the female being fed. Begging or feeding of one Blue Jay by another generally indicates that they are mated. Polyandrous matings are extremely rare among New World jays, even those that regularly breed in groups (Woolfenden 1976).

Nest 82-20 was the second nest for W-Y. I frequently saw W-Y feeding members of a group of 4 color-banded juveniles. I never saw any other adults feed these juveniles. In the other cases where I was able to follow fledglings, both parents fed the young. It is possible that W-Y had lost his mate, the mother of those 4 juveniles. I found W-W, W-Y, and bRW together on 6 occasions, as late as 28 November 1982. I did not see W-W after that date, but W-Y and bRW remained together throughout the 1983 breeding season and raised one juvenile together.

In a study of Blue Jays in Pennsylvania, Gross (1982) similarly found that their home ranges overlapped extensively. He also found 3 nests at each of which 3 birds showed some signs of parental behavior. At one nest, an unbanded jay fed the nestlings once. At another nest, an unbanded jay fed the nestlings twice and the breeding female twice. At the third nest, unbanded jay(s) fed the female twice. It is interesting to note that the breeding females would accept food from the "intruders," but the male breeders would chase them away. Gross (1982) considered these incidents unusual. He thought that some of

the birds might have lost their mates, or other factors might have caused them to abandon their home ranges, and that the feeding of other birds might have fulfilled their breeding drives.

Of the three factors that Emlen and Vehrencamp (1983) proposed to explain cooperative breeding (see introduction to Chapter 4), two can be quickly rejected. Habitat saturation by territorial species does not apply to Blue Jays because they are not territorial. There seems to be no lack of breeding habitat or nest sites for Blue Jays. Likewise, cooperative breeding by Blue Jays is not caused by any inability of pairs to breed successfully, due to either food shortage or predation pressure. Of 14 nests tended by pairs that I found during the egg or nestling stage, young fledged from 10 of them (71%). This overestimates actual nesting success by an unknown amount, since nests that fail in an early stage are less likely to be found than nests with young.

Shortage of mates might explain why some Blue Jays breed in trios rather than pairs. I could not determine the overall sex ratios, because many birds in my study population were unbanded each year. As mentioned above, it is possible that W-Y lost his first mate shortly after their first brood fledged. Mate shortage is not a complete explanation, because it does not explain why birds breed in trios rather than not breed at all. If a bird had just been involved in one breeding attempt, it might be in a physiological state conducive to further breeding. This could have happened with W-Y and some of the "helpers" reported by Gross (1982). Almost all of the color-banded jays that I saw regularly were breeders. One exception to this was

White, the offspring of W-Dg and Red in 1982. White was one of only two banded yearlings present at Corry Village in 1983 (the other was Black, White's sibling, whom I saw rarely). I was able to find White regularly and followed White for 156 min. I did not find a nest at which White was an attendant, nor did I see White engage in mate feeding or other courtship behavior. White also made no attempt to assist his parents.

There are several species of birds in which young from a first brood feed young from their parents' second brood (Skutch 1961). Such species include the Splendid Wren (Malurus splendens, Rowley 1981) and the Smooth-billed Ani (Crotophaga ani, Davis 1940). I saw no evidence of that kind of behavior in Blue Jays at the 4 nests that were attempts at second broods. Occasionally juveniles would visit nests and peer into them, but they made no attempt to feed. J. T. Reinholtz (pers. comm.) did see a juvenile feed one of its siblings under a feeder, in response to the sibling's begging.

The broadly overlapping home ranges of Blue Jays are similar to those of Steller's Jays, a closely related congener (Brown 1963b). Blue Jays were dominant over other jays near their own nests.

The evolution of territorial behavior has received much attention since Brown (1964) suggested that territoriality could be explained on the basis of costs and benefits to individual organisms. Territoriality is generally discussed with reference to some resource, usually food. If a food supply is predictable and moderately abundant, a bird could defend it with a limited expenditure of time and energy, thus insuring the continued presence of food. Feeding

territories generally are not found in species whose food supply is unpredictable in time and space, such as aerial insectivores (Brown 1964). A bird wastes time and energy by attempting to defend a food supply that will soon be depleted, especially if that food supply is temporarily abundant and many competitors are attracted to it. A bird would be better off to collect all the food it could while it is available. If numerous competitors are attracted, a bird might spend all of its time fighting with competitors rather than gathering food (Myers et al. 1979). If food is more evenly dispersed in time and space, a bird can benefit by defending a territory against all conspecifics. Most forest inhabiting insectivorous birds are territorial during the breeding season.

Blue Jays inhabit forests and woodlands, and during the breeding season they feed mostly on insects (pers. obs.), yet they are not territorial. Most of their food items appear to be rather evenly distributed in time and space, although I have no quantitative data on this. Acorns are the only Blue Jay food item that is temporarily super-abundant. Blue Jays do spend much time harvesting and caching acorns in the autumn, but they do not begin these activities until after all or most young are fledged. I have never seen Blue Jays gathering in groups to harvest ephemeral swarms of insects.

Blue Jays are omnivorous and opportunistic feeders. I have seen them eat moths, dragonflies, spiders, caterpillars, berries, acorns, lizards, bird eggs, bread crumbs, and bird seed. Perhaps they are not food-limited. If not, there would be no benefit to defending territory. Theories of territoriality assume that food or some other

resource is in limited supply, and must be defended. Being generalist feeders, Blue Jays might rarely face food shortages.

It is worth noting that all studies of Blue Jays and Steller's Jays to date have been conducted in areas where humans are common--parks, university campuses, residential areas. Blue Jays seem to be more common in such areas than away from humans. At Corry Village, at least 8 Blue Jays were resident in an area of 8 hectares, giving a density of over 40 birds/40 ha. In 38 breeding bird censuses conducted in forests in southeastern United States, Blue Jay densities ranged from 0.0 to 23.0 birds/40 ha (mean = 5.9; Van Velzen and Van Velzen 1982, 1983). Where the density of Blue Jays is high, the costs of territory defense might outweigh the benefits (cf. Myers et al. 1979). This raises questions about what factors regulate population density in Blue Jays. Unfortunately, no data are available concerning the relative importance of food supply, predation pressure, or other factors on Blue Jay density. A study of Blue Jays needs to be conducted at a site away from human activities, to determine if use of space by Blue Jays is influenced by population density, habitat structure, or food supply.

CHAPTER 6
EVOLUTION OF COOPERATIVE BREEDING IN NEW WORLD JAYS

Social Systems in Aphelocoma

The genus Aphelocoma exhibits a wide range of social systems. Several populations of Scrub Jays (Aphelocoma coerulescens) have been studied in California and New Mexico (Atwood 1980a, 1980b; Brown 1963a, 1974; Hardy 1961; Stewart et al. 1972; Verbeek 1973; Webber 1984). In none of these studies has more than a pair of birds been seen tending a nest, and Scrub Jays in most of those areas frequently breed when one year old. The exception to the last generalization is the Santa Cruz Island Scrub Jay (A. c. insularis), in which pairs do breed alone on all-purpose territories, but birds may not become breeders until they are 3-4 years old (Atwood 1980b). Florida Scrub Jays, as mentioned previously, breed as pairs or in small groups composed of one pair of breeders plus their offspring of previous years. Gray-breasted Jays (Aphelocoma ultramarina couchii) in the Chisos Mountains of Texas also breed in groups of 2-4 birds (Ligon and Husar 1974). In contrast, Gray-breasted Jays in southeastern Arizona (A. u. arizonae) live in groups of 8-20 birds with 2-4 breeding pairs per group (Brown 1963a, 1970, 1972). Scrub Jays in Florida, California, and New Mexico live in structurally similar habitats, dominated by shrubs or small trees at most a few meters tall (Pitelka 1951; Hardy 1961; Edwards MS). Scrub Jays in California also inhabit parks and open oak woodlands, but they

are not found in dense forests (Pitelka 1951; Salata 1982). Gray-breasted Jays occupy more arborescent oak-dominated woodlands or forests, including riparian woodlands (Pitelka 1951; Edwards MS).

Woolfenden (1975, 1981) has suggested that Florida Scrub Jays live in groups because of their narrow habitat tolerances. All available habitat is occupied, so young jays remain on their natal territories until breeding spaces become available. I am not convinced that the habitat tolerances of Florida Scrub Jays are much narrower than those of California Scrub Jays, but the Florida birds do have very little marginal habitat. They occupy almost all areas of treeless oak thickets in the Florida peninsula, and no other habitat in Florida even remotely resembles scrub. Gray-breasted Jays in Arizona also appear to occupy all suitable habitat, and Brown (1974) wrote that "the most productive territories of an area are handed down from generation to generation within the ownership of the same genetic lineages or clans" (p. 76). In southwestern New Mexico, Gray-breasted Jays are restricted to mixed pine-oak woodlands and make little use of the adjacent, more abundant habitats occupied by Scrub Jays. Gray-breasted Jays in Arizona and New Mexico dominate the Scrub Jays in adjoining habitats and exclude them from forested habitats (Brown 1963a; Edwards MS).

Even if cooperatively breeding populations of Aphelocoma do have narrower ecological tolerances than the non-cooperatively breeding populations, and hence saturate available habitat more readily, a question remains: Why do not the populations with broader tolerances fill up the available habitat and then have helpers? The answer must lie with the demography of the various populations. If reproductive

success and/or survivorship were lower in some populations, fewer birds would enter the pool of potential breeders, and the more frequent deaths of breeders would create more opportunities for other birds to breed. The only western population of Scrub Jays for which long-term demographic data exist is that on Santa Cruz Island, California (A. c. insularis).

Mortality of breeding Scrub Jays on Santa Cruz Island is 6-9% annually. For non-breeders, annual mortality is no more than 25% and is probably somewhat lower (Atwood 1980b). These figures are similar to, and possibly slightly lower than, the comparable figures for Florida Scrub Jays (12-20%, Stallcup and Woolfenden 1978). Unlike other populations of Scrub Jays, the birds on Santa Cruz Island may live in marginal habitat without breeding for 3-4 years (Atwood 1980b).

Koenig and Pitelka (1981) suggested that an important factor in the evolution of cooperative breeding is the ratio of optimal habitat to marginal habitat. If optimal habitat is saturated with occupied territories and marginal habitat is scarce, retention of non-breeding birds in their natal territories is expected. If considerable marginal habitat is available, birds should disperse into that habitat unless there are profound benefits for living in groups. Koenig (1981) showed that per capita breeding success does not increase with group size in several species of cooperatively breeding birds. In other words, individuals of some species would obtain higher inclusive fitness by breeding independently if they could. Few data on mortality of birds living in groups were available to Koenig, and the data he did examine did not show that birds in larger groups have significantly lower

mortality than those in smaller groups. As an example, annual mortality of breeding Florida Scrub Jays in groups of 3 or more birds is 12%; that of birds breeding in pairs is 20% (Stallcup and Woolfenden 1978). The difference is not statistically significant at the P=0.05 level (Koenig 1981, contra Stallcup and Woolfenden 1978). I suggest that the difference might still be biologically significant. Furthermore, additional data have shown that Scrub Jays breeding in groups do have significantly lower mortality than those in pairs (McGowan 1983).

Most discussions of the possible advantages of group breeding have suffered from two problems: 1) They have measured reproductive success as the number of fledglings produced, not as the number of offspring eventually entering the breeding population (e.g., Koenig 1981, but see Woolfenden 1975). Because of dispersal, it is difficult in many populations to determine how many offspring do eventually breed, but these data are crucial to understanding the evolution of social behavior. 2) Most studies have been limited to a few years in duration, so data on lifetime reproductive success have not been obtained. It is lifetime reproductive success--a combination of fecundity and survivorship--that is important, not merely annual production of offspring. In the absence of long-term demographic data, any discussion of the costs and benefits of group living vs. singular living must remain tentative.

Jays in Disturbed or Changing Habitats

The Florida Scrub Jay is the second species for which there is evidence that retention of young birds in the natal territory might be an adaptation for life in disturbed, transient habitats. If disturbed habitat is created at a rate great enough for all potential breeders to establish territories, then birds can disperse and breed as soon as they are sexually mature. If the amount of space required for all birds to breed independently is somewhat greater than the amount of disturbed habitat, some birds will have to refrain from breeding, either by remaining on their natal territories and possibly becoming helpers, or by becoming floaters, if marginal habitat is available. Although not residents of disturbed habitats, Santa Cruz Island Scrub Jays illustrate the latter choice--they may live in marginal habitat without breeding for 3-4 years (Atwood 1980b). Florida Scrub Jays in Ocala National Forest take the former option--they act as helpers until new habitat is created to which they can disperse. At Archbold Biological Station, new habitat is seldom if ever created by disturbance, so Scrub Jays there remain as helpers until a breeder dies or a territory can be subdivided.

Several species of Middle American jays also inhabit disturbed areas. The "black-and-blue" jays of the genus Cyanocorax (subgenus Cissilopha) all occupy habitats that are disturbed to some extent, and some of the species occupy disturbed habitats almost exclusively (Hardy et al. 1981). Brown Jays (Cyanocorax morio) also inhabit disturbed areas (Skutch 1935; Selander 1959; Lawton and Guindon 1981). All of these species breed cooperatively.

In flocks of Brown Jays, young birds may receive active instruction in foraging behavior from older birds (Lawton and Lawton MS). This may be especially important in the disturbed, changing habitats they occupy at Monteverde, Costa Rica. The older birds may be familiar with the types of food and nest sites available in the entire range of habitats, and younger birds may benefit from prolonged association with them (Lawton in litt.).

Among the black-and-blue jays, there is a direct correlation between the degree of habitat disturbance and the complexity of social organization. Beechey Jays (Cyanocorax beecheii) inhabit second-growth deciduous forest subject to selective cutting in western Mexico. Groups are small (2-6 birds) and each contains only one pair of breeders (Raitt and Hardy 1979; Winterstein and Raitt 1983). Southern San Blas Jays (C. sanblasianus sanblasianus) live farther south in western Mexico in groups of 13-26 birds with 6-10 breeding pairs per group (Hardy et al. 1981). They nest in groves of coconut palms and at the edges of broad-leaved scrub near coconut groves, but avoid the interior of extensive forests. The other black-and-blue jays (Yucatan Jay, C. yucatanicus; Bushy-crested Jay, C. melanocyaneus; and Nelson San Blas Jay, C. sanblasianus nelsoni) inhabit areas of intermediate degrees of disturbance and have social systems of intermediate complexity (Hardy 1976; Raitt and Hardy 1976).

Southern San Blas Jays have the most complex social structure reported for any New World jay (Hardy et al. 1981). The complexity may be a response to life in a heavily disturbed environment (see below); this begs the questions, however, of what the natural habitat

of Southern San Blas Jays is, and what their social system is under undisturbed conditions. The habitat and social system of the Beechey Jay may approximate those of all black-and-blue jays under natural conditions.

Humans have occupied Middle America since the late Pleistocene, and began domesticating food crops 7000 years ago (MacNeish 1958, 1964; Flannery 1973). At that time, human population densities in Middle America were still very low, but permanent settlements were widespread there by 1500-1000 B.C. Brown Jays and black-and-blue jays may have been living in association with humans for several millenia. Through the middle of the Pleistocene, savanna environments were widespread in Middle America (Webb 1978). During the Pleistocene, black-and-blue jays may have inhabited the savannas or the savanna/forest ecotone (Hardy 1976). By the end of the Pleistocene, the amount of savanna habitat had decreased substantially (Webb 1978), and the black-and-blue jays may have become rare and locally distributed. Savannas are now present in certain areas of Middle America, but these were probably created by regular fires of human origin, beginning 3000 or more years ago (Lundell 1937).

Is helping behavior normal and adaptive?

In most studies of cooperative breeding in birds, it has been implicitly assumed that the observed helping behavior is both normal and adaptive. These separate assumptions are not trivial, and each shall be addressed in turn.

In one year of a long-term study, Price et al. (1983) observed a high frequency of helping behavior in the Cactus Finch, Geospiza scandens. Helping behavior by Darwin's finches has not been observed in other years, and Price et al. interpreted this behavior as misdirected parental care by birds that were unable to breed themselves that year. If their study had been made with unbanded birds in just that one year, they might have received the impression that such helping behavior was typical for the species, when in fact it is not.

As discussed previously, helpers at the nest have been reported in Blue Jays (Chapter 5; Gross 1982). These instances seem to be aberrant can also be interpreted as misdirected parental care. Also falling in this category are the numerous cases of interspecific parental care summarized by Skutch (1961). Such bizarre cases as a Northern Cardinal (Cardinalis cardinalis) feeding goldfish demonstrate the intensity of breeding drives in birds.

In Brown Jays, it seems likely that the extremely variable social system at Monteverde, Costa Rica, is also somewhat aberrant. Breeding groups may have just one nest with eggs laid by only one female, one nest in which several females lay eggs, or two nests active simultaneously or sequentially (Lawton and Lawton MS). In the expanding, heavily disturbed Brown Jay habitat at Monteverde, many of the flocks are composed primarily of young, inexperienced birds. As a result, young birds, which might normally be prevented from breeding by older birds, are frequently breeders. In Florida Scrub Jays, there is a linear, age-related dominance hierarchy, and older birds prevent younger birds in the same group from breeding (Woolfenden and

Fitzpatrick 1977). Brown Jay flocks lacking older birds may not have a well-defined dominance hierarchy, so that many birds that are codominant or nearly so breed simultaneously, in various combinations.

In addition, the black-and-blue jays discussed above all occupy habitats that are more-or-less disturbed. Southern San Blas Jays have the most complex social system, occupy the most heavily disturbed habitats, and have the greatest population density of any of these jays. Although age at first breeding is 2-3 years for other populations of black-and-blue jays, some Southern San Blas Jays breed when only one year old (Hardy et al. 1981). It is possible that the social systems observed in all Middle American jays living in disturbed habitats are direct responses to the disturbed habitats, and are somewhat abnormal. In disturbed habitats, the forces that normally structure breeding groups may be broken down, with the result that certain otherwise inhibited behaviors become commonplace. For example, Hardy et al. (1981) suggested that in large groups, the dominant birds may be unable to prevent other group members from breeding. Why groups of Southern San Blas Jays are so large is another matter; it may be a result of habitat saturation or population density. Food for these jays may be more plentiful in the palm plantations where they nest than in undisturbed woodlands (ibid.). This could lead to increased population density with a resultant breakdown in dominance hierarchies. Studies of these jays in undisturbed habitats, if any still exist, are necessary to test this hypothesis.

In contrast, I believe that the social behavior of Florida Scrub Jays in Ocala National Forest is normal, even though the habitat is

disturbed. Clear-cutting in ONF is extremely similar to fire in its effects on the sand pine scrub, and Scrub Jays have had thousands of years to adapt to the fire regime there. The social system of Scrub Jays in ONF differs from that at Archbold Biological Station primarily in the availability of an additional means of territory acquisition--the opportunity to move into newly-created habitat.

Is helping behavior by birds adaptive? In a discussion of cooperative breeding in birds, it is useful to distinguish two separate questions: 1) Why do some birds remain on their natal territories? and 2) Why do they help? (Emlen 1982a, 1982b; Emlen and Vehrencamp 1983). The answer to the first question is probably this: Because ecological constraints of one sort or another prevent them from breeding independently (Emlen 1982a; Emlen and Vehrencamp 1983; and see above discussion). Remaining on familiar ground in the natal territory probably yields greater fitness to a non-breeder than wandering off into unfamiliar, possibly unsuitable habitat.

The second question, "Why do non-breeders help?" is more difficult to answer. In many cases the observed forms of helping (feeding of nestlings and fledglings, anti-predator behavior) may be non-adaptive. Williams (1966) proposed that morphological, physiological, and behavioral characters should not be considered adaptations molded by natural selection unless the evidence clearly supports such a conclusion. This view stems from the principle of logical parsimony, more succinctly known as Ockham's razor ("entities are not to be multiplied beyond necessity"). More recently, Lewontin (1979) and Gould and Lewontin (1979) attacked the "adaptationist program" along

similar lines, Lewontin (1979) with specific reference to sociobiology. Anti-predator behavior and feeding of young birds may reflect merely the genetic constitution and physiological state of the "helper," rather than being adaptive per se. Helping behavior may be a consequence of natural selection acting on other aspects of the animal's behavior, rather than directly on helping. Behavior such as giving alarm calls to protect one's offspring from predators is adaptive, and it may be unavoidable that other individuals benefit from that behavior as well. Also, given certain hormone levels at a certain time of year, feeding of nestlings may be inevitable. In altricial species, it is certainly adaptive for parents to feed their own offspring. The several cases of interspecific helping (Skutch 1961) attest to the strength of breeding drives in birds. In an evolutionary sense, it may not be possible to "turn off" the feeding of nestlings by non-breeders without also turning off the feeding of nestlings by those same birds when they become breeders, especially if the cost of helping to the helper is small. Price et al. (1983) found that helping behavior by Cactus Finches did not adversely affect either future survival or future breeding by the helpers. Perhaps Williams (1966) was correct in stating that the "helper phenomenon can be attributed to selection pressures for the maintenance of a certain pattern of parental behavior, with a less-than-perfect system of timing mechanisms for regulating this behavior" (p. 208). A better question than "Why do non-breeders help?" might be, "What prevents these birds from breeding on their natal territories?"

There have been numerous attempts to explain the adaptive value of helping behavior, invoking individual selection (e.g., Zahavi 1974), kin selection (e.g., Ricklefs 1975), reciprocity (e.g., Ligon and Ligon 1983), or various combinations of all three factors (e.g., Brown and Brown 1981b; Emlen and Vehrencamp 1983). The idea that helping behavior might not be adaptive per se is not new (Williams 1966; Price et al. 1983), but cooperative breeding in birds has not been reviewed with this thought in mind. I shall not attempt a comprehensive review of the literature, but will focus on a few well-studied species.

In Florida Scrub Jays, a linear, age-related dominance hierarchy exists among males within a group, and probably also within females (Woolfenden and Fitzpatrick 1977). Although the oldest male helpers sometimes provide as much food as the male breeders for nestlings, they may be inhibited from breeding by the more dominant male breeders. Hardy and Raitt (1974) presented evidence that breeding Yucatan Jays suppress breeding by subordinate individuals, at least in captivity. Male Scrub Jay breeders are particularly aggressive toward male helpers during and immediately prior to egg-laying (Woolfenden and Fitzpatrick 1977). Male breeders may not be able to suppress all breeding drives by helpers, however, and those drives are expressed in the feeding of nestlings and fledglings. Yearlings, which typically provide less help than older birds (Stallcup and Woolfenden 1978), may have their breeding drives suppressed more than older male helpers, since they are subordinate to even more birds.

Stallcup and Woolfenden (1978) presented evidence that the amount of aid given by a Florida Scrub Jay helper is proportional to the

benefit it might later receive: Male helpers provide much more food to nestlings than do female helpers, and they stand to acquire part of the parental territory to breed in in the future, whereas females must disperse to become breeders. More recent evidence indicates, however, that female helpers feed fledglings just as much as male helpers do (McGowan 1983), so the previous information must be reinterpreted. Female helpers do try to visit nests with young, but are frequently prevented from doing so by breeders and male helpers, thus accounting for the discrepancy in feeding rates by male and female helpers during the nestling stage (Stallcup and Woolfenden 1978). This tale vividly demonstrates the need for long-term studies of all aspects of a species' biology, using individually marked birds of known pedigree.

Gray-breasted Jays frequently have 2 or more nests active simultaneously within one group. The breeding females from each nest feed the young of the other breeding pairs in the same group as frequently as they feed their own young (Brown and Brown 1980). Brown and Brown (1980) suggested that this behavior could be explained if all jays obeyed the following rule: "'feed members of your own unit but not those of other units'" (p. 319). Because Gray-breasted Jay groups generally consist of extended families (Brown and Brown 1981a), this behavior could have evolved through kin selection. Brown and Brown (1980) presented no evidence that female breeders actively seek out any particular individuals to feed. In fact, they characterize the feeding of young by parents as "indiscriminate." Because Gray-breasted Jays are territorial, adults are unlikely to feed young in any group other than their own. A simpler rule than that proposed by Brown and Brown (1980) would be, "feed any young you see."

Most studies of cooperatively breeding birds have demonstrated a benefit to the breeders--larger breeding groups fledge more young than smaller groups (Brown 1978; Koenig 1981). In addition, breeding Florida Scrub Jays with helpers have higher annual survivorship than those without helpers, perhaps as a result of improved protection against predators (Stallcup and Woolfenden 1978).

Benefits to non-breeders, other than those associated merely with remaining in the natal territory, are less clear. Among those that have been mentioned are obtaining breeding experience and increased survivorship by living in a group (Emlen 1978). There are few data showing that the increment in inclusive fitness obtained by helping is greater than that obtained by breeding independently. As discussed previously, per capita reproductive success does not increase with group size in several species of cooperatively breeding birds (Koenig 1981). Koenig (1981) and Koenig and Pitelka (1981) concluded that birds of these species should breed in groups only as a last resort.

Novice Florida Scrub Jay breeders have low reproductive success (Woolfenden 1975; Emlen 1978), but Scrub Jay helpers have no reproductive success outside of that shared with the recipients of their help. Non-breeders may obtain increased survivorship by remaining in a group on familiar ground, but this does not address the question, "Why do they help?"

Among the jays, the best evidence of benefit to a "helper" comes from the study of Brown Jays. Lawton and Guindon (1981) distinguished 3 age-classes of birds by soft-part colors: "Young", birds roughly 1-2 years old; "Intermediate", 3 years old; and "Old", 4 or more years old.

The number of fledglings produced per flock was strongly correlated with the number of Old birds in a flock. Furthermore, Young birds frequently made mistakes when bringing food to nestlings: They brought food items that were too large for the nestlings to swallow, they ate the nestling food themselves, and they were easily distracted before feeding the nestlings. Old and Intermediate birds did not make the first two types of errors and, more importantly, the numbers of mistakes made by Young birds decreased as the nesting season progressed. Young Brown Jays probably do benefit from helping, but these data do not show that it is important for Brown Jays to help for more than one year before they can breed successfully. Brown Jays frequently do not breed until 3 or more years old (Lawton and Guindon 1981). Even where suitable habitat is available, Brown Jays do not disperse to breed in pairs. New flocks seem to form by the splitting of old flocks, and contain 5-10 birds (Lawton and Lawton MS). Why Brown Jays form such large groups remains unknown.

Summary and Conclusions

Among jays of the genus Aphelocoma, a wide range of social systems is found, from pairs breeding alone, to single pairs breeding with assistance from a few other birds, to groups of 8-20 birds with 2-4 breeding pairs. The group-breeding populations are restricted to certain specific types of habitat. This habitat specificity has been proposed as a causal factor in the evolution of cooperative breeding in these species. Populations with narrow habitat tolerances can readily occupy all available habitat, with the result that some individuals may

have to refrain from breeding. Without data on natality and mortality from a variety of populations, this proposition is difficult to test. There is no reason why populations with broad habitat tolerances should not saturate their habitats, unless reproductive success and/or survivorship is lower. Studies of several years' duration of several different populations of Aphelocoma jays are needed before cooperative breeding in these jays can be truly understood.

One population of Florida Scrub Jays, and several species of Mexican and Central American jays, breed cooperatively and inhabit disturbed, and in some cases transient, habitats. For Florida Scrub Jays and Brown Jays, cooperative breeding may be adaptive towards life in changing environments, though for different reasons. Florida Scrub Jays in Ocala National Forest remain on their natal territories until new habitat is created elsewhere, then disperse and breed on their own. For Brown Jays, young birds may obtain knowledge of appropriate foods and nest sites in changing habitats by associating with older birds for a protracted length of time.

The black-and-blue jays of Middle America also breed cooperatively and occupy disturbed habitats. This group shows a correlation between complexity of breeding system and degree of habitat disturbance. It is proposed that the social complexity of the populations in the most heavily disturbed habitats is a direct, possibly non-adaptive response to the disturbance regime. The populations that inhabit the most heavily disturbed habitats also have the largest group sizes and the greatest population densities, possibly as a result of greater food abundance. Given a high population density, the dominant breeders may be unable to prevent other birds from breeding.

Certain aspects of helping behavior seen in New World jays may not be the result of natural selection acting on helping behavior per se, but rather may be the inevitable consequences of selection for normal parental behavior. A bird that will breed sometime during its lifetime must have a particular genetic and physiological constitution that will permit breeding. Given that genetic and physiological makeup, a bird may feed nestlings or fledglings in its territory even if it cannot breed itself.

Retention of non-breeding offspring in the parents' territory, as seen in Florida Scrub Jays, probably is adaptive. If the habitat is saturated and the probability of finding unoccupied habitat in which to breed is low, remaining on the natal territory may lead to a greater probability of surviving to breed later than would dispersing to unfamiliar and possibly unsuitable habitat.

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APPENDIX
LOCATIONS OF FLORIDA SCRUB JAY POPULATIONS,
1980-1983

Alachua County

1. W of Archer, about 3-1/2 mis due W of Archer, just N of Levy Co. line/ SE 1/4 Sec 11, T11S, R17E/6 SJ, 11 Jun 1980; 2 SJ, 7 Apr 1981/ atypical turkey oak scrub, gradually being cleared (continuous with Levy Co. 1).

Brevard County

1. CAPE CANAVERAL, S and W sides of Jetty Park; W side N Atlantic Ave, just S Eberwein Rd; E side Ridgewood Ave, at Beach St; W side N Atlantic Ave, just S Church Lane/ NW, NE, and SE quarters Sec 14, NW 1/4 Sec 23, T24S, R37E/ 6 SJ, 18 May 1981/ remnant coastal scrub, being developed.

2. CAPE CANAVERAL AIR FORCE STATION, almost all areas/ parts of Secs 24, 25, 26, T22S, R37E; Sec 31, T22S, R38E; Secs 1, 12, 13, 23, 24, 25, 26, 35, 36, T23S, R37E; Secs 5, 6, 7, 8, 16, 17, 18, 19, 20, 21, 28, 29, 30, 31, 32, 33, T23S, R38E; Secs 1 and 2, T24S, R37E; Sec 6, T24S, R38E/ 70 SJ, 23 Jul 1981/ coastal scrub and oak scrub; some cleared, most intact.

3. N of COCOA, "Port St Johns" development, W of US 1, about 6 mis N SR 528 (Bee Line Expressway), vicinity of Apple Ave and Janina Rd/ E 1/2 Sec 23, T23S, R35E/ 2 SJ, 25 Jul 1981/ scattered patches of oak scrub, being developed rather quickly.

4. COURTENAY, on Chase Hammock Rd, about 2 mis E of Courtenay Parkway (SR 3)/ SW 1/4 Sec 25, NW 1/4 Sec 36, T23S, R36E/ 2 SJ, 19 May 1981/ disturbed 2-3 m oak scrub.

5. COURTENAY, E side Courtenay Pkwy (SR 3), 0.4 mis N Chase Hammock Rd/ SW 1/4 Sec 26, T23S, R36E/ 1 SJ, 19 May 1981/ open slash pine scrub.

6. COURTENAY, W side Courtenay Pkwy (SR 3), about 1 mi N SR 528/ SW 1/4 Sec 2, T24S, R36E/ 1 SJ, 19 May 1981/ open slash pine scrub.

7. GRANT, E side Brabrook Rd, about 0.25-0.5 mis S Grant Rd/ NE 1/4 Sec 33, T29S, R38E/ 5 SJ, 13 May 1981/ open slash pine scrub.

8. GRANT, SW of corner Old Dixie Highway and Main St/ SW 1/4 Sec 34, T29S, R38E/ 2 SJ, 13 May 1981/ 1-2 m second-growth oak scrub.

9. INDIAN HARBOR BEACH, W side SR A1A, between Satellite Ave and Pine Tree Dr/ NW 1/4 Sec 12, T27S, R37E/ 1 SJ, 18 May 1981/ coastal scrub; small portions cleared.

10. INDIAN HARBOR BEACH, S of Eau Gallie Blvd (SR 518), between SR A1A and S Patrick Dr/ W 1/2 Sec 13, E 1/2 Sec 14, T27S, R37E/ 5 SJ, 18 May 1981/ coastal scrub, being cleared.

11. INDIAN HARBOR BEACH-INDIALANTIC, along S Patrick Dr between Sand Pine Rd and Monaco Dr/ NE 1/4 Sec 23, W 1/2 Sec 24, NW 1/4 Sec 25, T27S, R37E/ 2 SJ, 18 May 1981/ 3 m coastal scrub, scattered 10 m sand pines; some land cleared or being cleared, some scrub left on lots with houses.

12. MELBOURNE, E of Croton Rd, 0.4 mis N Parkway Dr; N part of "Quail Ridge" development/ SW 1/4 Sec 5, T27S, R37E/ 2 SJ, 20 May 1981/ 1-2 m oak scrub, some 15 m sand pines; being developed.

13. MELBOURNE, Cape Kennedy Regional Airport, along Apollo Blvd/ SE 1/4 Sec 28, T27S, R37E/ 4 SJ, 20 May 1981/ scattered patches of disturbed scrub.

14. MELBOURNE BEACH, N side 2nd St, just E of Oak St; S side Oak St, between Orange St and Cherry St; N side of Oak St, just W of baseball park/ W 1/2 Sec 8, T28S, R38E/ 4 SJ, Nov 1980 (S. Burr, in litt.); 7-8 SJ, 12 May 1981 (J. A. C.); 4 ad, 1 juv SJ, 2 Sep 1982 (J. A. C.)/ remnant 2-3 m oak scrub on vacant lots between houses; being developed.

15. MELBOURNE BEACH, just N intersection SR A1A and Oak St, between Spessard Holland Park and Spessard Holland Golf Course/ N 1/2 Sec 17, T28S, R38E/ 2 SJ, 12 May 1981/ 2-3 m oak scrub; clearing appears likely in near future.

16. between MELBOURNE BEACH and FLORIDANA BEACH, along SR A1A on barrier island/ SE 1/4 Sec 17, NE corner Sec 20, W 1/2 Sec 21, E 1/2 Sec 28, NE 1/4 Sec 33, SW 1/4 Sec 34, T28S, R38E; middle (N-S) Sec 3, E 1/2 Sec 10, SW corner Sec 11, NW 1/4 Sec 14, T29S, R38E/ 7 SJ, 12 May 1981/ remnant patches of coastal scrub among various types of developments, entire area being developed.

17. MERRITT ISLAND, along Newfound Harbor Dr, about 1/2 mi S Cutter Court; and about 0.3 mis S Embassy Arms Dr (Riverpoint Program Center, Girl Scouts)/ SE 1/4 Sec 7, NE 1/4 Sec 18, T25S, R37E/ 1 SJ each place, 18 May 1981 (J. A. C.); 3 SJ, summer 1982 (J. Johnson, in litt.)/ open slash pine scrub.

18. MERRITT ISLAND, E side Newfound Harbor Dr, between Merrimac Dr and Kessler Dr/ center Sec 31, T24S, R37E/ SJ reported by local resident, 18 May 1981/ open slash pine scrub, surrounded by houses.

19. MERRITT ISLAND NATIONAL WILDLIFE REFUGE: see text and reports by Salata (1980) and Breininger (1981).

20. W of MICCO, N side Micco Rd, 0.1-0.3 mis W I-95 crossing/ NE 1/4 Sec 14, T30S, R37E/ 3 SJ, Dec 1981 (M. C. Bowman, in litt.); 3 SJ, 28 Dec 1982 (J. A. C.)/ 1-3 m oak scrub, surrounded by palmetto scrub, some burned in 1982.

21. MICCO, W of US 1, on Senne Rd; also S side Senne Rd, just W of FEC RR tracks/ SE 1/4 Sec 3, NE 1/4 Sec 10, T30S, R38E/ 3-4 SJ, 13 May 1981/ disturbed scrub and burned sand pine scrub (now with many dead snags and 1-2 m oaks).

22. MICCO, "Barefoot Bay" development, corner of Barefoot Bay Blvd and Osprey Rd/ SE 1/4 Sec 10, T30S, R38E/ 1 SJ, 13 May 1981/ remnant slash pine scrub nearby; being developed.

23. MICCO, W side US 1, about 0.8 mis N Micco Rd; Indian River Shores Trailer Park/ NW 1/4 Sec 11, T30S, R38E/ 7 SJ, Nov 1980 (M. C. Bowman, in litt.).

24. MICCO, on Fleming Grant Rd, 0.2-1.5 mis S Micco Rd/ middle (N-S) Sec 15, N 1/2 Sec 22, T30S, R38E/ 2 SJ, Nov 1980 (M. C. Bowman, in litt.); 2 SJ, 13 May 1981 (J. A. C.)/ open slash pine scrub, some cleared.

25. MICCO, "Little Hollywood" section; Honeysuckle Dr at Azalea, and Primrose Dr at Wisteria/ SW 1/4 Sec 23, T30S, R38E, and Tract 20, Fleming Grant/ 2 SJ, Nov 1981 (S. Burr, in litt.); 5 SJ, 13 May 1981 (J. A. C.)/ remnant sand pine scrub between houses, gradually being cleared.

26. MIMS, about 2.5 mis N SR 46 on US 1, and one block E to Old Dixie Highway; between Joel Ave and Gloria Ave/ center Sec 6, T21S, R35E/ 1-2 SJ heard, 25 Jul 1981/ oak scrub, some cleared for houses.

27. PINEDA, along US 1 and FEC RR, roughly 0.0-1.5 mis N Pineda Ave (N and S of Florida Memorial Gardens)/ S 1/2 Sec 1, middle (N-S) Sec 12, T26S, R36E/ 2-4 ad, 3 juv SJ, 20 May 1981/ mostly sand pine scrub, some areas of 2-3 m oak scrub.

28. SATELLITE BEACH, W side S Patrick Dr, between Cassia Blvd and Inwood Lane/ W 1/2 Sec 2, T27S, R37E/ 2 SJ, 18 May 1981/ coastal scrub with some sand pines, developments all around.

29. N of SCOTTSMOOR, along US 1, between C-5A and Volusia Co. line/ NW 1/4 Sec 1, T20S, R34E/ 3 SJ, 21 Aug 1981/ slash pine scrub, scattered houses.

30. SCOTTSMOOR, along US 1, 0.4 mis S St Johns Rd/ NE 1/4 Sec 24, T20S, R34E/ 2 SJ, 25 Jul 1981/ oak scrub.

31. TITUSVILLE, on Carpenter Rd, 0.0-0.5 mis N Fox Lake Rd/ middle (N-S) Sec 7, T22S, R35E/ 2 SJ, 25 Jul 1981/ oak scrub.

32. TITUSVILLE, along Sisson Rd, 0.0-1.0 mis N SR 405/ middle (N-S) Sec 34, T22S, R35E/ 2 SJ, 25 Jul 1981/ oak scrub.

33. TITUSVILLE, E side US 1, 0.0-1.0 mis N SR 405; E and W of US 1, 0.0-0.75 mis S SR 405/ E 1/2 Sec 35, T22S, R35E; W 1/2 Sec 1, T23S, R35E/ 4 SJ, 25-26 Jul 1981; 1 SJ, 16 Sep 1982/ 1-2 m oak scrub, scattered snags and slash pines; areas S of SR 405 posted "For Sale".

34. VALKARIA, on Valkaria Rd around N and W sides of Valkaria Airport/ SE 1/4 Sec 7, NW 1/4 Sec 17, middle (NE-SW) Sec 18, T29S, R38E/ 3-4 SJ, Nov 1980 (S. Burr, in litt.; M. C. Bowman, in litt.); 14 SJ, 13 May 1981 (J. A. C.); 3 SJ, 28 Dec 1982 (J. A. C.)/ 2-4 m oak scrub.

35. SW of VALKARIA, E and W of Babcock St, 0.25-0.55 mis N of Grant Rd/ W 1/2 Sec 27, E 1/2 Sec 28, T29S, R37E/ 5 SJ, 28 Dec 1982/ 1-2 m oak scrub, some clearings in area.

Charlotte County

1. CHARLOTTE HARBOR, vicinity of Edgewater Dr and Midway Rd/ parts of Secs 19, 20, 29, and 30, T40S, R22E/ SJ reported by M. Simons (in litt.) and O. Hewitt (pers. comm.)/ disturbed scrub, being cleared for houses.

2. N of GROVE CITY, on Eileen Place, 0.2 mis E of Oxford St; "New Point Comfort"/ NW 1/4 Sec 5, T41S, R20E/ SJ reported by O. Hewitt (pers. comm.); 2 ad, 2 juv SJ, 7 Aug 1981 (J. A. C.)/ low density residential area, some slash pine scrub left.

3. PLACIDA, E side SR 775, 1.5 mis N SR 771/ SW 1/4 Sec 2, T42S, R20E/ 1 SJ, 7 Aug 1981/ slash pine scrub.

4. NE of PUNTA GORDA, on north part of Shell Creek Loop Road (C-764), 1.0-2.2 mis E US 17/ SW 1/4 Sec 16, S 1/2 Sec 17, T40S, R24E/ 5 ad, 1 juv SJ, 6 Aug 1981/ mixed palmetto scrub and slash pine scrub, some pasture N of road.

5. SE of PUNTA GORDA, N of Acline Rd, about 3/4 mis E of SR 765A/ NE 1/4 Sec 27, T41S, R23E/ about 6 pairs of Scrub Jays, reported by S. A. Nesbitt (in litt.).

6. N of ROTONDA WEST, Wildflower Golf Course, 4.4 mis N SR 771 and 0.7-1.2 mis E SR 775/ NW 1/4 Sec 27, NE 1/4 Sec 28, T41S, R20E/ SJ reported by K. Carstens (in litt.), M. Simons (in litt.), and O. Hewitt (pers. comm.); 1 SJ, 7 Aug 1981 (J. A. C.)/ oak scrub and slash pine scrub, some being developed.

7. ROTONDA WEST, on SR 775, 3.2-4.2 mis N SR 771/ E 1/2 Sec 28, NE 1/4 Sec 33, T41S, R20E/ 4 SJ, 7 Aug 1981/ slash pine scrub, some cleared.

Citrus County

1. N of CRYSTAL RIVER, along US 19-98, just S of Cross-Florida Barge Canal/ SE 1/4 Sec 11, T17S, R16E/ SJ reported by L. F. Snyder (in litt.); 2 SJ, 21 Feb 1981 (J. A. C.)/ palmetto scrub, scattered pines.

2. N of CRYSTAL RIVER, "Crystal Manor" development, E of US 19-98, N of SR 488/ SE 1/4 Sec 12, NE 1/4 Sec 13, T17S, R16E; SW 1/4 Sec 7, NW 1/4 Sec 18, T17S, R17E/ 11 SJ, 21 Feb 1981; estimated 11.7 SJ/40 ha, 1982 census/ grass and palmetto scrub; gradually being developed; study site CRMP.

3. N of CRYSTAL RIVER, on C-495, 2.8 mis N US 19-98; just north of high-power line/ SE 1/4 Sec 4, T18S, R17E/ 2 SJ, 31 Jul 1983/ palmetto-oak scrub.

4. CRYSTAL RIVER, N side C-44, 2.1 mis W US 19-98/ SW 1/4 Sec 29, T18S, R17E/ 3 SJ, 31 Jul 1983/ 1-2 m oak scrub, many dead snags.

5. CRYSTAL RIVER, S side SR 44, about 1.5 mis W US 19-98/ NE 1/4 Sec 32, T18S, R17E/ 2 SJ, 26 Mar 1981 (J. W. Hardy, in litt.)/ oak scrub.

6. N of HERNANDO, on SR 39, about 0.5 mis W of SR 200, beneath high-power line, just S of Withlacoochee River/ SE 1/4 Sec 24 or NE 1/4 Sec 25, T17S, R19E/ 2 SJ, 5 Mar 1981/ second-growth oak scrub.

7. N of HERNANDO, on SR 200, 0.65 mis S SR 39/ SE 1/4 Sec 25, T17S, R19E/ 1 SJ, 5 Mar 1981/ 2-3 m oak scrub.

8. NE of INVERNESS, S side C-581, about 1.2 mis SW of end of C-581 at Turner/ NE 1/4 Sec 27, T18S, R20E/ 2 SJ, 5 Mar 1981/ 1-3 m oak scrub between houses.

9. SE of INVERNESS, McGregor Smith Scout Reservation/ Sec 29, T19S, R21E/ SJ reported by P. C. Anderson, Ranger (in litt.)/ oak scrub.

Clay County

1. SE side of CAMP BLANDING MILITARY RESERVATION, W side SR 21, 0.9 mis SW C-315/ SE 1/4 Sec 19, T7S, R24E/ 3 SJ, 4 Feb 1981/ disturbed scrub with planted 2 m slash pines.

2. GOLD HEAD BRANCH STATE PARK, NE of Deer Lake/ NE 1/4 Sec 36, T17S, R23E/ 3 SJ, 25 Jan 1980; 3 or 7 SJ, 2 Feb 1981/ 2-5 m oak scrub.

Collier County

1. IMMOKALEE, W side Immokalee Airport, on Airport Access Rd, 0.0-1.7 mis N C-846/ E 1/2 Sec 34, T46S, R29E; NE 1/4 Sec 3, T47S, R29E/ 5-10 SJ, Jan-Feb 1981 (Cutlip ms.); 2 SJ, 5 Aug 1981 (J. A. C.)/ oak scrub, palmetto scrub, open slash pine scrub.

DeSoto County

1. NW of ARCADIA, along Manatee Co. line, about 1.5-2 mis N SR 70/ NW 1/4 Sec 30, T36S, R23E/ SJ reported by S. L. Cawley (pers. comm.)/ oak scrub (continuous with Manatee Co. 3).

2. E of ARCADIA, 14 mis E of Arcadia and 3.1 or 4.5 mis S of SR 70, on Bright Hour Ranch near Cow Slough/ Sec 16 or 21, T38S, R27E/ several SJ reported by F. E. Lohrer (in litt.)/ oak scrub.

Flagler County

1. FLAGLER BEACH STATE RECREATION AREA/ NE 1/4 Sec 30, T12S, R32E/ C. Thorndike, Ranger, reported that a pair of SJs fledged 2 young in the park, summer 1981 (pers. comm.)/ coastal scrub.

2. MARINELAND, on SR A1A, 0.45-2.8 mis S St. Johns Co. line/ NE edge Tract 38, unnamed land grant/ 1-3 SJ, Oct 1980-Oct 1981/ coastal scrub, some posted "For Sale".

Glades County

1. N of PALMDALE, on US 27, about 2 mis N of Palmdale/ SE 1/4 Sec 21 or NE 1/4 Sec 28, T40S, R30E/ 1 SJ, 22 Mar 1980/ oak scrub.

2. NE of PALMDALE, Fisheating Creek Wildlife Management Area, E of US 27/ NE 1/4 Sec 24, T40S, R30E; NW 1/4 sec 19, T40S, R31E/ SJ reported by L. E. Williams (pers. comm.).

3. W of PALMDALE, Fisheating Creek Wildlife Management Area, N of Fisheating Creek, W of US 27/ SW 1/4 Sec 25, N 1/2 Sec 36, T40S, R29E; middle (E-W) Sec 31, S 1/2 Sec 32, T40S, R30E/ SJ reported by L. E. Williams (pers. comm.).

4. W of PALMDALE, Fisheating Creek Wildlife Management Area; N side SR 74, 1.2-3.6 mis W SR 29; S side SR 74, 1.2-2.7 mis W SR 29/ E 1/2 Sec 1, T41S, R29E; S 1/2 Sec 6, NE corner Sec 7, N 1/2 Sec 8, T41S, R30E/ SJ reported by P. W. Sykes (pers. comm.), L. E. Williams (pers. comm.), and F. E. Lohrer (in litt.); 32 ad, 14 juv SJ, 4 Aug 1981 (J. A. C.)/ 2-3 m oak scrub, some recently cleared.

5. PALMDALE, square loop of SR 733 around E side of town/ SW 1/4 Sec 34, T40S, R30E; NW 1/4 Sec 3, T41S, R30E/ 2 ad, 3 juv SJ, 4 Aug 1981/ oak and palmetto scrub, some cleared for houses.

6. SW of PALMDALE, W side SR 29, about 6 mis SW of Palmdale/ SE 1/4 Sec 36(?), T41S, R29E/ 2 SJ, 22 Mar 1980/ palmetto scrub.

7. SW of PALMDALE, W side SR 29, 0.6-1.0 mis N Hendry Co. line/ NW 1/4 Sec 28, T42S, R29E/ 1 SJ, 17 Oct and 20 Nov 1980 (E. S. Clark, in litt.); 1 SJ, 22 Mar 1980 (J. A. C.); 3 ad, 1 juv SJ, 5 Aug 1981 (J. A. C.)/ palmetto scrub.

8. SE of PALMDALE, NE side of junction US 27 and SR 29 (by Cypress Knee Museum)/ N 1/2 Sec 10, T41S, R30E/ SJ reported by F. E. Lohrer (in litt.)/ 3 m sand-live oaks.

9. SE of PALMDALE, Fisheating Creek Wildlife Management Area, N of US 27/ Sec 12, T41S, R30E/ SJ reported by L. E. Williams (pers. comm.).

10. W of ORTONA, along SR 78, just east of SR 29/ S edge Sec 15, N edge Sec 22, T42S, R29E/ SJ reported by E. S. Clark (in litt.) and H. W. Kale II (in litt.).

11. W of ORTONA, S side SR 78, 0.95-1.6 mis E SR 29/ N edge Sec 23, T42S, R29E/ SJ reported by E. S. Clark (in litt.); 2 SJ, 6 Aug 1981 (J. A. C.)/ oak and palmetto scrub.

12. W of ORTONA, N side SR 78, 2.3-2.5 mis W C-78A/ SE 1/4 Sec 18, T42S, R30E/ 1 SJ, 20 Nov and 13 Dec 1980 (E. S. Clark, in litt.)/ 3 m oak scrub.

13. ORTONA, N side Ortona Cemetery, on SR 78, 1 mi E C-78A (Ortona Rd)/ SW 1/4 Sec 14, T42S, R30E/ 1 SJ, 6 Aug 1981/ small patch of 2-3 m oak scrub.

Hardee County

1. W of LIMESTONE, on SR 665, 4.9-6.0 mis W SR 663/ SW 1/4 Sec 34, T35S, R23E; N 1/2 Sec 3, T36S, R23E/ 5 SJ, 6 Sep 1981/ mosaic of sand pine scrub, palmetto scrub, scrubby pasture, turkey oak scrub, citrus, and pastures.

Hernando County

1. RIDGE MANOR, "Ridge Manor Estates," W of US 301, about 3 mis N SR 50/ parts of Secs 24, 25, and 26, T22S, R21E/ SJ reported by James Cox (in litt.) and S. B. Fickett (in litt.); 10 SJ, 13 Jun 1981 (J. A. C.)/ mosaic of sand-live/myrtle oak scrub and second-growth turkey oak scrub; gradually being developed.

2. E of RIDGE MANOR, on west side of Richloam Wildlife Management Area, on dirt road about 0.75 mis N SR 50/ NE 1/4 Sec 6, T23S, R22E/ locality reported by S. B. Fickett (in litt.)/ oak scrub.

3. WEEKI WACHEE, junction US 19 and SR 50, and about 1/2 mi in each direction/ N 1/2 and SE 1/4 Sec 2, T23S, R17E/ SJ reported by S. B. Fickett (in litt.); 5 SJ, 13 Jun 1981 (J. A. C.); 3 SJ, 12 Dec 1982 (J. A. C.)/ large area of sand pine scrub and oak scrub, some burned in Jun 1971; some sand pines now up to 6 m tall.

Highlands County

1. NW of AVON PARK, "Highland Lakes" development/ parts of Secs 5, 6, 7, 8, and 18, T33S, R28E/ 2 SJ, 3 Aug 1981/ oak scrub, some second-growth scrub; roads laid out, few houses in most areas.

2. E of AVON PARK, on Old Bombing Range Rd, 0.5-0.9 mis W SR 64/ NE 1/4 Sec 8, NW 1/4 Sec 9, T33S, R29E/ 2 ad, 2 juv SJ, 1 Aug 1981/ oak scrub.

3. E of AVON PARK, on Avon Pines Rd, 0.1 mi W Marion Rd to River Dale Rd; on Marion Rd, 0.0-1.0 mis S Avon Pines Rd; on River Dale Rd, 0.0-0.2 mis N Avon Pines Rd/ S 1/2 Sec 21, middle (N-S) Sec 28, T33S, R29E/ 16 ad, 2 juv SJ, 1 Aug 1981/ oak scrub, some cleared for houses.

4. S of AVON PARK, "Sun N'Lakes" development, W of US 27, about 4 mis S SR 64; N of Sun N'Lakes Blvd, on Columbus Dr and Ponce de Leon Blvd/ S 1/2 Sec 4, S 1/2 Sec 5, W 1/2 Sec 8, T34S, R28E/ SJ reported by A. F. Johnson (in litt.); 8 ad, 5 juv SJ, 3 Aug 1981 (J. A. C.)/ mixed oak scrub and sand pine scrub, beginning to be developed.

5. AVON PARK BOMBING RANGE, on Old Bravo Rd, 0.9 mis N Kissimmee Rd/ NE 1/4 Sec 1, T33S, R30E/ 3 SJ, 1 Aug 1981/ oak scrub.

6. HICORIA, Archbold Biological Station/ all quadrants Secs 6, 7, 18, 19, 30, and 31, part of Sec 8, T38S, R30E/ about 400 SJ (Woolfenden and Fitzpatrick in press)/ primarily oak scrub; includes study site ABSP.

7. HICORIA, along "Old SR 8" (= SR 17) between Archbold Rd and extreme S end Archbold Biological Station (4.65 mis S Archbold Rd); also on Archbold Rd, Kelley Rd, and Hicoria Rd, between "Old SR 8" and US 27/ S edge Sec 8, middle (E-W) and W 1/2 Sec 17, SE 1/4 Sec 19, W 1/2 and S 1/2 Sec 20, middle (N-S) Secs 30 and 31, T38S, R30E; W 1/2 Sec 6, T39S, R30E/ 13 ad, 1 juv SJ, 4 Aug 1981 (excluding birds seen on Archbold Biological Station)/ oak scrub, sand pine scrub, slash pine scrub; much has been cleared for citrus and houses.

8. HIGHLANDS HAMMOCK STATE PARK, primitive camping area/ E 1/2 Sec 4, T35S, R28E/ 2 ad, 1 juv SJ, 3 Aug 1981/ sand-live oaks and saw palmettoes.

9. NW of LAKE PLACID, just NE of corner of Payne Rd and Lake Josephine Rd/ SW corner Sec 36, T35S, R28E/ 2 SJ, 4 Aug 1981/ palmetto scrub.

10. NW of LAKE PLACID, W side Henscratch Rd, 0.0-0.15 mis S Lake Josephine Rd; on Lake Josephine Rd, 0.0-0.6 mis W Henscratch Rd/ S 1/2 Sec 36, T35S, R28E; N 1/2 Sec 1, T36S, R28E/ 4 SJ, 4 Aug 1981/ oak scrub, many 6-8 m sand pines; much of area burned 1980-81.

11. NW of LAKE PLACID, on Henscratch Rd, 1.4-2.5 mis N SR 621 (Miller Ave)/ E edge Secs 12 and 13, T36S, R28E; W edge Secs 7 and 18, T36S, R28E/ 9 ad, 3 juv SJ, 4 Aug 1981/ palmetto scrub and scrubby pasture.

12. NW of LAKE PLACID, "Leisure Lakes" development, on SR 621 (Miller Ave), 4.05 mis W US 27/ NE 1/4 Sec 28, T36S, R29E/ 2 SJ, 4 Aug 1981/ vacant lot between houses, no scrub in sight.

13. NW of LAKE PLACID, S side SR 621 (Miller Ave), 3.35 mis W US 27 (corner of Miller Ave and Pine St)/ NW 1/4 Sec 27, T36S, R29E/ 3 SJ, 4 Aug 1981/ small patch of oak scrub.

14. NW of LAKE PLACID, E side SR 621, 1.4 mis W US 27/ NE 1/4 Sec 26, T36S, R29E/ 2 SJ, 4 Aug 1981/ small patch of oak scrub.

15. NW of LAKE PLACID, N side SR 621, 0.7-1.15 mis W US 27/ center Sec 25, T36S, R29E/ 2 SJ, 4 Aug 1981/ disturbed scrub.

16. NE of LAKE PLACID, along gravel road toward boat landing on W side of Lake Istokpoga, N of "Highland Park Estates" (northward continuation of Virginia Ave)/ S 1/2 Sec 4, middle (N-S) Sec 9, N

1/2 Sec 16, T36S, R30E/ 18 ad, 10 juv SJ, 31 Jul 1981/ mostly oak scrub, some sand and slash pines, some areas cleared or "For Sale".

17. E of LAKE PLACID, on SR 621, between SR 619 and Virginia Ave/ S 1/2 Sec 33, T36S, R30E/ 5 SJ, 31 Jul 1981/ oak scrub, some sand pines and turkey oaks.

18. E of LAKE PLACID, on Holmes Ave, between SR 29 and SR 621 (E of Lake Huntley)/ SE 1/4 Sec 32, SW 1/4 Sec 33, T36S, R30E; W edge Secs 4 and 9, E edge Secs 5 and 8, T37S, R30E/ SJ seen 19 Jan 1981 (E. T. Rasmussen, fide F. E. Lohrer, in litt.); 10 ad, 7 juv SJ, 31 Jul 1981 (J. A. C.)/ mostly oak scrub, some sand and slash pines, some areas cleared.

19. E of LAKE PLACID, on SR 619, between SR 29 and SR 621/ W edge Secs 3 and 10, E edge Secs 4 and 9, T37S, R30E/ 6 ad, 1 juv SJ, 31 Jul 1981/ oak scrub, sand pine scrub, citrus, hardwoods, pasture.

20. LAKE PLACID, "Placid Lakes" development, S of Lake June in Winter and W of Lake Placid, including Placidview Dr south to 1 mi N SR 70/ most of Secs 10, 11, 14, 15, SW 1/4 Sec 13, E edge Secs 23 and 26, W edge Secs 24 and 25, T37S, R29E/ SJ reported by A. F. Johnson (in litt.) and F. E. Lohrer (in litt.); 41-42 ad, 6 juv SJ, 29-30 Jul 1981 (J. A. C.)/ extensive areas of oak scrub, smaller areas of other habitats; Secs 11 and 14 heavily developed, Secs 10 and 15 being developed.

21. S of LAKE PLACID, on Placidview Dr between Lake Mirror Dr and Washington Blvd NE/ SE 1/4 Sec 12, middle (NE-SW) Sec 13, T37S, R29E/ 11 ad, 1 juv SJ, 31 Jul 1981/ oak scrub, some citrus and houses.

22. S of LAKE PLACID, on US 27 between Lake Placid and SR 70/ parts of Secs 6, 7, 8, 17, 20, 28, and 33, T37S, R30E/ 1-2 SJs on several occasions/ scattered remnants of oak scrub, most cleared.

23. S of LAKE PLACID, "Sun N'Lakes" development, E of Grassy Lake/ E 1/2 Sec 21, W 1/2 Sec 22, T37S, R30E/ 11 ad, 2 juv SJ, 31 Jul 1981/ scattered areas of oak scrub, being developed (especially western portions).

24. S of LAKE PLACID, "Bear Hollow," N of SR 70, about 1.0-1.5 mis E US 27/ middle (N-S) Sec 27, E 1/2 Sec 34, T37S, R30E/ 23 ad, 5 juv SJ, 31 Jul 1981/ oak scrub; substantial portions developed.

25. S of LAKE PLACID, on SR 70 from US 27 west to 2.5 mis W SCL RR tracks/ S edge Secs 35 and 36, T37S, R29E; S edge Secs 31 and 32, T37S, R30E; N edge Secs 1 and 2, T38S, R29E; N edge Secs 5 and 6, T38S, R30E/ 8 ad, 2 juv SJ, 29 Jul-3 Aug 1981/ oak scrub, some cleared.

26. S of LAKE PLACID, on SR 70, 0.5-2.15 mis E US 27/ S edge Secs 33, 34, and 35, T37S, R30E; N edge Secs 2, 3, and 4, T38S, R30E/ 10 ad, 1 juv SJ, 31 Jul 1981/ mostly oak scrub, some cleared.

27. S of LAKE PLACID, on US 27, from SR 70 to 3.15 mis N SR 731, and various unpaved roads up to one mile east of US 27 (southern end of Lake Wales Ridge)/ W 1/2 Secs 4, 9, 16, 21, 28, and 33, T37S, R30E; W 1/2 Sec 4, T38S, R30E/ 19-20 ad, 3 juv SJ, 4-5 Aug 1981/ apparently all formerly scrub, about 65% of land along US 27 has been cleared for citrus, more is "For Sale".

28. LORIDA, E side Cow House Rd, about 1 mi S US 98 (at corner of Hacienda Dr)/ NW 1/4 Sec 21, T35S, R31E/ 2 SJ, 31 Jul 1981/ palmetto scrub.

29. SE of LORIDA, on US 98, 1.25 mis E Istokpoga Canal/ NE 1/4 Sec 32, T35S, R32E/ 2 ad, 1 juv SJ, 31 Jul 1981/ pasture, 3 m scrub oaks along fence.

30. SE of LORIDA, on US 98, 1.5-2.55 mis E Istokpoga Canal/ S 1/2 Sec 33, T35S, R32E/ SJ seen 13 Jan 1981 (J. G. Taylor, Jr., in litt.); 6 ad, 2 juv SJ, 31 Jul 1981 (J. A. C.)/ oak scrub, burned 3-5 years previously.

31. SE of LORIDA, "Cornwell," on US 98, about 3 mis W SR 721/ NW 1/4 Sec 2, T36S, R32E/ 2 SJ, 31 Jul 1981/ small patch of scrub.

32. W of SEBRING, on Schumacher Rd, 0.45-1.2 mis W US 27/ S 1/2 Sec 15, N 1/2 Sec 22, T34S, R28E/ 2 ad, 1 juv SJ, 3 Aug 1981/ palmetto scrub, scattered slash pines.

33. W of SEBRING, W of US 27, about 1 mi S SR 634A; on Northside Rd, 3rd St, and Thunderbird Rd/ SW 1/4 Sec 23, T34S, R28E/ 1 SJ, 3 Aug 1981/ rosemary scrub, some sand pines; roads laid out, a few houses.

34. W of SEBRING, on SR 634, 0.45-0.75 mis W US 27/ S edge Sec 35, T34S, R28E; N edge Sec 2, T35S, R28E/ 1 ad, 2 juv SJ, 3 Aug 1981/ 1-2 m oak scrub.

35. W of SEBRING, on SR 634, 1.5-1.75 mis W US 27/ S edge Sec 34, T34S, R28E; N edge Sec 3, T35S, R28E/ 2 ad, 1 juv SJ, 3 Aug 1981/ disturbed 1-2 m oak scrub.

36. NE of SEBRING, on Arbuckle Creek Rd (SR 700A), 0.75-2.15 and 2.3-2.5 mis E SR 17A/ NW 1/4 Sec 14, middle (E-W) Secs 15 and 16, T34S, R29E/ 2 SJ, 3 Aug 1981/ oak scrub, some sand pines and turkey oaks.

37. NE of SEBRING, on Hart Rd, 0.5-1.0 mis S Arbuckle Creek Rd/ middle (N-S) Sec 14, T34S, R29E/ 2 SJ, 3 Aug 1981/ oak scrub and scrubby pasture.

38. SEBRING, on SR 17S, 0.3-0.35 mis N US 27, just N Southgate Shopping Center/ SW 1/4 Sec 32, T34S, R29E/ 1 SJ, 3 Aug 1981/ remnant oak scrub.

39. SW of SEBRING, on SR 635, 2.1-2.2 mis S SR 634/ NW 1/4 Sec 15, NE 1/4 Sec 16, T35S, R28E/ 2 ad, 2 juv SJ, 3 Aug 1981/ open slash pine scrub.

40. SW of SEBRING, on SR 635, 0.3-1.45 mis N SR 66/ SW 1/4 Sec 15, SE 1/4 Sec 16, E 1/2 Sec 21, W 1/2 Sec 22, T35S, R28E/ 1 ad, 1 juv SJ, 3 Aug 1981/ mostly 10 m sand pine scrub, some oak scrub and scrubby pasture.

41. SW of SEBRING, on Sparta Rd, 1.9 mis N SR 66/ NW 1/4 Sec 17, T35S, R29E/ 3 ad, 1 juv SJ, 3 Aug 1981/ disturbed oak scrub.

42. SW of SEBRING, on SR 66, 0.8-0.9 mis E Payne Rd/ SE 1/4 Sec 24, NE 1/4 Sec 25, T35S, R28E/ 1 ad, 1 juv SJ, 3 Aug 1981/ slash pine scrub.

43. S of SEBRING, on SR 66, 1.35-2.0 mis W US 27/ middle (NE-SW) Sec 20, T35S, R29E/ SJ seen 13 Jan 1981 (J. G. Taylor, Jr., in litt.); 3 ad, 1 juv SJ, 4 Aug 1981 (J. A. C.)/ open slash pine scrub.

44. S of SEBRING, on SR 66, 0.9-1.05 mis W US 27/ NW 1/4 Sec 21, T35S, R29E/ 3 ad, 1 juv SJ, 4 Aug 1981/ oak scrub.

45. S of SEBRING, on Skipper Rd, 0.2-0.45 mis W US 27/ SE 1/4 Sec 21, NE 1/4 Sec 28, T35S, R29E/ 3 SJ, 4 Aug 1981/ 1-2 m oak scrub.

46. SE of SEBRING, S side US 98, 0.25-1.65 mis E SR 17 (E to Albritton Rd); and on Albritton Rd and Ranchero Rd, S of US 98/ SW 1/4 Sec 13, S 1/2 Sec 14, NW 1/4 Sec 24, T35S, R29E/ SJ seen 13 Jan 1981 (J. G. Taylor, Jr., in litt.); 7 ad, 4 juv SJ, 1 Aug 1981 (J. A. C.)/ oak scrub, some cleared for houses.

47. NW of VENUS, N side Sheppard Rd (= Boothill Rd), 1.25-1.5 mis W "Old SR 8" (= SR 17)/ NE 1/4 Sec 16, T39S, R29E/ 1 SJ, 4 Aug 1981/ palmetto scrub, scattered slash pines.

48. W of VENUS, on SR 731, 1.05-1.2 mis W "Old SR 8" (= SR 17)/ NW 1/4 Sec 22, T39S, R29E/ 2 ad, 2 juv SJ, 4 Aug 1981/ 2-3 m oak scrub along road, sand and slash pines farther back.

49. SW of VENUS, on SR 731, just N of Glades Co. line/ S 1/2 Sec 31, T39S, R29E/ 4 ad, 2 juv SJ, 4 Aug 1981/ 10 m planted slash pines, a few myrtle oaks along road.

50. NE of VENUS, W side US 27, 1.8-2.0 mis N SR 731/ SE 1/4 Sec 8, T39S, R30E/ 2 SJ, 5 Aug 1981/ 2 m oak scrub, scattered slash pines.

51. VENUS, N side SR 731, 0.25-1.2 mis W US 27/ S 1/2 Secs 19 and 20, T39S, R30E/ 3 ad, 1 juv SJ, 4 Aug 1981/ open slash pine scrub.

52. E of VENUS, about 1 mile E of US 27; Hendrie Ranch/ E 1/2 Sec 9, T39S, R30E/ SJ reported by A. F. Johnson (in litt.)/ oak scrub.

53. S of VENUS, E side US 27, 0.15-0.4 mis S SR 731/ SE 1/4 Sec 20, T39S, R30E/ 2 SJ, 4 Aug 1981/ oak scrub.

Hillsborough County

1. N of PICNIC, about 2 mis N and 0.5 mis E of Picnic/ SW 1/4 Sec 8, NW 1/4 Sec 17, T31S, R22E/ SJ reported by T. Gilbert (in litt.)/ oak scrub.

2. SE of RUSKIN, just N of Little Manatee River near I-75/ N 1/2 Sec 29, T32S, R19E/ SJ reported by M. Welton (pers. comm.) and R. W. Repenning (pers. comm.)/ palmetto scrub and scrubby pasture.

Indian River County

1. ROSELAND, E side C-505, along W side Sebastian Municipal Airport, from about 1/4 mi N to 1 mi S of Donald MacDonald Park/ E corner, Fleming Grant/ 4 SJ, Nov 1980 (M. C. Bowman, in litt.); 3 SJ, 12 May 1981 (J. A. C.)/ 1-3 m oak scrub, scattered sand and slash pines.

2. WINTER BEACH, on C-632, 0.4 mis W Old Dixie Highway; on west side of county dump/ E 1/2 Sec 9 or W 1/2 Sec 10, T32S, R39E/ 2 SJ, 12 May 1981/ 2-3 m oak scrub, a few 4-5 m sand pines.

3. WINTER BEACH, on dirt road S from C-632, 0.3 mis W Old Dixie Highway (behind American Lifestyle Mfg)/ SW 1/4 Sec 10, T32S, R39E/ 3 SJ, 12 May 1981/ disturbed 2-6 m oak scrub.

4. WINTER BEACH, Bent Pine Golf Course, E of C-505, between Pecan Grove Rd and Storm Grove Rd/ NE 1/4 Sec 17, T32S, R39E/ 1-3 SJ, 1980-1982 (M. C. Bowman, in litt.)/ remnant scrub.

5. WINTER BEACH, E side Old Dixie Highway, 1.0 mis S C-632/ NE 1/4 Sec 15, T32S, R39E/ 3 SJ, 12 May 1981/ disturbed remnant scrub.

Lake County (excluding sites in Ocala National Forest)

1. E of ASTATULA, on C-48, 2.5-3.0 mis E C-561/ S edge Sec 22, N 1/2 Sec 27, T20S, R26E/ 4 SJ, 1 Apr 1981/ oak scrub with scattered sand pines.

2. SE of ASTATULA, on Ranch Road (about 1.2 mis E C-561), 1.0-2.5 mis S C-48/ most of Sec 4, NE 1/4 Sec 9, T21S, R26E/ 20 SJ, 1 Apr 1981/ mostly 2-4 m oak scrub, being cleared for houses.

3. S of ASTATULA, on Sugarloaf Mountain Rd, just W C-561/ NE 1/4 Sec 19, T21S, R26E/ 2 SJ, 31 Mar 1981/ oak scrub and scrubby pasture.

4. NE of CASSIA, on SR 44, 6.3 mis S SR 42/ NW 1/4 Sec 17, T18S, T29E/3 SJ, 5 Apr 1981/ 2 m oak scrub.

5. NE of CASSIA, on SR 44, 7.7 mis SW SR 42/ NE 1/4 Sec 19, T18S, R29E/ 2 SJ, 1 Apr 1981; 3 SJ, 5 Apr 1981/ 1-2 m oak scrub with scattered slash pines.

6. N of CASSIA, on dirt road [extension of paved road through "Royal Trails" (see Lake Co. 8)], 7.0 mis SW SR 42, about 3.5 mis NW SR 44; near grass landing strip/ Sec 11, T18S, R28E/ 3 SJ, 31 Dec 1980 (T. Engstrom, in litt.).

7. NE of CASSIA, "Royal Trails" development, W side SR 44, 7.0 mis S SR 42/ S 1/2 and NW 1/4 Sec 18, T18S, R29E/ 2 SJ, 31 Dec 1980 (T. Engstrom, in litt.); 12 SJ, 1 Apr 1981 (J. A. C.)/ mostly oak scrub, mixed with ponds and slash pines; being developed.

8. SW of CASSIA, S side SR 44, 2.0 mis SW of C-44A/ SW 1/4 Sec 3 or SE 1/4 Sec 4, T19S, R29E/ 3 SJ, 1 Apr 1981/ 1-2 m oak scrub.

9. S of CLERMONT, on Hull Road, immediately NW of Lake Louisa/ NW 1/4 Sec 7, T23S, R26E/ 3 SJ, 14 Jun 1981/ 1-2 m oak scrub, south part being cleared for houses.

10. SW of CROWS BLUFF, W of SR 44, 2.5 mis S SR 42; "Palomino Pines"/ NW 1/4 Sec 27, T17S, R29E/ 9 SJ, 31 Dec 1980 (T. Engstrom, in litt.)/ scrub, being developed.

11. S of CROWS BLUFF, on SR 44, 3.25 mis SW SR 42/ SE 1/4 Sec 33, T17S, R29E/ 3 SJ, 5 Apr 1981/ 1-2 m oak scrub, some being cleared.

12. NE of EUSTIS, W side C-439, about 0.7 mis N C-44A/ NW 1/4 Sec 34, T18S, R27E/ 2 SJ, 5 Apr 1981/ 2-3 m oak scrub.

13. E of EUSTIS, on C-44A, 1-2 mis E C-439/ SE 1/4 Sec 35, SW 1/4 Sec 36, T18S, R27E/ SJ reported by B. S. Burton (in litt.) and D. Brigham (in litt.); 8 SJ, 31 Mar 1981 (J. A. C.)/ mixed oak scrub and sand pine scrub.

14. S of HOWEY-IN-THE HILLS, along O'Brien Rd, just W SR 19/ SW 1/4 Sec 11, NW 1/4 Sec 14, T21S, R25E/ 11 SJ, 31 Mar 1981; 4 SJ, 20 Mar 1983/ scrubby pasture and citrus groves.

15. S of HOWEY-IN-THE-HILLS, E side SR 19, just N Florida's Turnpike/ NE 1/4 Sec 22, T21S, R25E/ 4 SJ, 31 Mar 1981/ scrubby old citrus grove.

16. S of HOWEY-IN-THE-HILLS, on US 27, about 1 mi E SR 19/ SE 1/4 Sec 22, T21S, R25E/ 4 SJ, 31 Mar 1981/ scrubby pasture.

17. MOUNT DORA, E side SR 19A, 0.6 mis S US 441; behind Bob's Nursery/ NW 1/4 Sec 6, T19S, R26E/ SJ reported by G. Bretz (pers. comm.) and D. Brigham (in litt.)/ remnant oak scrub.

18. MOUNT DORA, S of Old US 441 and SCL RR, between Fairview and Boyd/ S 1/2 Sec 26, T19S, R26E/ SJ reported by D. Brigham (in litt.); 1 SJ, 12 Jun 1981 (J. A. C.); 1 SJ, 20 Mar 1983 (J. A. C.)/ disturbed remnant oak scrub.

19. E of MOUNT DORA, SW of junction Wolf Branch Rd and Britt Rd/ NE corner Sec 28, T19S, R27E/ 2 SJ, 12 Jun 1981/ 2-3 m oak scrub, some sand pines.

20. NE of MOUNT PLYMOUTH, on C-46A, about 2.2-2.3 mis SE of SR 44/ NE 1/4 Sec 21, T19S, R28E/ 2 SJ, 31 Mar 1981/ oak scrub.

21. E of MOUNT PLYMOUTH, on SR 46, 1.65 mis E C-435/ NW 1/4 Sec 27, T19S, R28E/ 1-2 SJ, 3 Oct 1981/ pasture with a few scrub oaks and sand pines.

22. SE of MOUNT PLYMOUTH, on C-433, about 2 mis S SR 46, along Orange Co. line/ S 1/2 Sec 31, T19S, R29E/ 2 SJ, 31 Mar 1981/ mixed oak scrub, palmetto scrub, and sand pine scrub (continuous with Orange Co. 2).

23. SW of OKAHUMPKA, on SR 48, 0.9 mis SW of Florida's Turnpike/ NE 1/4 Sec 29, T20S, R24E/ SJ reported by D. K. Voigts (in litt.); 1 ad, 1 juv SJ, 14 Jun 1981 (J. A. C.); 2 SJ, 20 Mar 1983 (J. A. C.)/ strip of scrub oaks along SCL RR bed and SR 48, between Florida's Turnpike and Center Hill, Sumter Co. (continuous with Sumter Co. 1).

24. SE of PAISLEY, about 4.5 mis SE of Johnson's Corner (on SR 42) on dirt road/ NE 1/4 Sec 10, T18S, R28E/ 2 SJ, 12 Jun 1981/ 2-3 m oak scrub, surrounded by sand pine scrub.

25. NW of TAVARES, "Bassville," junction C-473 and Northern Rd, and just N junction Haines Creek Rd and Park Rd/ NW 1/4 Sec 13, T19S, R25E/ SJ reported by B. S. Burton (in litt.); 5 ad, 1 juv SJ, 12 Jun 1981 (J. A. C.)/ remnant oak scrub.

Lee County

1. W of ALVA, on SR 78, 0.0-1.0 mis E SR 31/ S edge Sec 7, N edge Sec 18, T43S, R26E/ 2-5 SJ, Nov-Dec 1980 (E. S. Clark, in litt.)/ scattered patches of oak scrub.

2. W of ALVA, N side SR 78, 1.9 mis E SR 31/ SE 1/4 Sec 8, T43S, R26E/ 1 SJ, 22 Mar 1980/ pastures and palmetto scrub with scattered slash pines.

3. W of ALVA, on SR 78, about 3 mis E SR 31/ NE 1/4 Sec 16, T43S, R26E/ 1-2 SJ, 1-20 Dec 1980 (E. S. Clark, in litt.).

4. ALVA, on SR 78 near Bay Street/ S 1/2 Sec 15, N 1/2 Sec 22, T43S, R27E/ 2 SJ, 22 Mar 1980/ residential area, some myrtle oaks.

5. E of ALVA, on SR 78, 1.5-2.5 mis W Hendry Co. line/ S edge Secs 14 and 15, N edge Secs 22 and 23, T43S, R27E/ 1-2 SJ, Nov-Dec 1980 (E. S. Clark, in litt.)/ scattered patches of oak scrub, some for sale.

6. ALVA, N side SR 80, 0.4-1.1 mis E SR 873; S side SR 80, 0.0-0.8 mis E SR 873/ middle (E-W) Sec 26, T43S, R27E/ 3 SJ, 6 Aug 1981/ 3-7 m oak scrub, some cleared away from road.

7. OLGA, on Old Olga Rd, 0.5 mis N SR 80 (near corner Bigelow and Biglow Streets), and 0.05-0.1 mis farther east/ S 1/2 Sec 21, T43S, R26E/ SJ reported by J. Hanvey (in litt.); 2 SJ, 22 Mar 1980 (J. A. C.); 1 SJ, 15-30 Nov 1980 (E. S. Clark, in litt)/ oak scrub, some being cleared.

8. OLGA, S bank Caloosahatchee River, W of Linwood Ave/ NE 1/4 Sec 21 or NW 1/4 Sec 22, T43S, R26E/ SJ reported by J. Hanvey (in litt.); 4 SJ, 6 Aug 1981 (J. A. C.)/ disturbed oak scrub.

Levy County

1. NE of BRONSON, about 7 mis NE of Bronson, about 2.5 mis N SR 24/ NE 1/4 Sec 14, T11S, R17E/ 5-7 SJ, Sep 1979-Jun 1980/ pasture with scattered oaks and pines (continuous with Alachua Co. 1).

2. N of CEDAR KEY, on C-347, 0.9-1.2 mis N C-326/ SE 1/4 Sec 28, NE 1/4 Sec 33, T14S, R13E/ 5 SJ, 2-4 Mar 1981/ scattered areas of oak scrub.

3. N of CEDAR KEY, on unpaved road (0.4 mis N C-326), 0.0-1.0 mis E C-347/ E 1/2 Sec 33, middle (E-W) Sec 34, T14S, R13E/ 7 SJ, 2 Mar 1981/ oak scrub; some cleared.

4. N of CEDAR KEY, E and W of C-347, 0.0-1.2 mis S C-326; and S of C-326, 0.0-0.4 mis W C-347/ S 1/2 Sec 33, T14S, R13E; all parts of Sec 4, T15S, R13E/ 23 SJ, 2-4 Mar 1981/ oak scrub, some areas of other habitat types; some portions cleared.

5. N of CEDAR KEY, Cedar Key Scrub State Preserve, W of C-347, S of C-326/ SE 1/4 Sec 5, W 1/2 Sec 9, T15S, R13E/ 16-17 SJ, 2 Mar 1981/ oak scrub.

6. N of CEDAR KEY, Cedar Key Scrub State Preserve, N side SR 24, 1.2 mis N C-347/ NE 1/4 Sec 19, T15S, R13E/ 4 SJ, Sep 80/ oak scrub, scattered slash pines.

7. S of CHIEFLAND, W side C-341, 1.5 mis S C-345/ SE 1/4 Sec 11, T12S, R14E/ 2 SJ, 4 Mar 1981/ atypical scrub (lots of oaks, not typical scrub species), gradually being cleared for houses.

Manatee County

1. BRADENTON, east of corner of 83rd Street NW and 9th Avenue NW/ SW 1/4 Sec 19 or NW 1/4 Sec 30, T34S, R17E/ 1-2 SJ seen regularly, 1982-83 (D. D. Fulghum, in litt.)/ remnant scrub.

2. W of MYAKKA CITY, N side Singletary Rd, 0.0-0.5 mis E Sarasota Co. line/ NW 1/4 Sec 18, T36S, R21E/ 2 SJ, 7 Sep 1981/ oak scrub, "For Sale".

3. SE of MYAKKA CITY, along DeSoto Co. line, about 1.5-2 mis N SR 70/ NE 1/4 Sec 25, T36S, R22E/ SJ reported by S. L. Cawley (pers. comm.)/ oak scrub (continuous with DeSoto Co. 1).

4. N of MYAKKA HEAD, east side of Duette Rd, 2.8-3.5 mis N SR 64/ E 1/2 Sec 23, T34S, R22E/ 1 SJ, 15 Apr 1983/ palmetto scrub and scrubby pasture.

Marion County (excluding sites in Ocala National Forest)

1. W of BELLEVIEW, "Marion Oaks" development, S of C-484, entrance 1.2 mis W I-75/ parts of Secs 10, 11, 14, 15, 22, 23, 26, and 27, T17S, R21E/ 2 SJ, 11 Nov 1979; 17 SJ, 18 Feb 1981/ mixture of oak scrub and mature sand pine scrub, being developed.

2. SW of BELLEVIEW, on C-475 just N of Sumter Co. line (just E of I-75)/ SE 1/4 Sec 32, T17S, R22E/ 6 SJ, 21 Feb 1981; 2 SJ, 11 Jun 1981/ open slash pine scrub.

3. NW of CANDLER, "Silver Springs Shores" development, S side C-464, about 2 mis NW of Candler/ E 1/2 Sec 21, SW 1/2 Sec 22, T16S, R23E/ 5 SJ, 25 Feb 1981; 10 SJ, 7 Mar 1981/ oak scrub and sand pine scrub, being developed.

4. N of EUREKA, on Daisy Rd, 0.7-1.0 mis N of C-316/ SE 1/4 Sec 5, T13S, R24E/ 6 SJ, 29 Jan 1981/ oak scrub, mostly east of road.

5. OCALA, on C-225A, about 1 mi E Ocala Municipal Airport, opposite Good Shepherd Memorial Gardens/ SE 1/4 Sec 21, SW 1/4 Sec 22, T15S, R21E/ 2 SJ, 25 May 1981/ 3-4 m second-growth sand-live oaks in pasture.

6. SW of OCALA, E off SR 200, "Ocala Waterway" development/ all quadrants Sec 27 (and much surrounding land), T16S, R21E/ 40 SJ, 19 Feb 1981; estimated 19.3 SJ/40 ha, 1982 census/ sand pine scrub burned 16 May 1977, regenerating as 1-2 m oak scrub; unpaved roads, few houses (none in area that was burned); study site BGSP.

Martin County

1. JONATHAN DICKINSON STATE PARK, along FEC RR tracks, from main park road north to N park boundary/ middle (N-S) Sec 35, T39S, R42E; middle (N-S) Sec 2, NE 1/4 Sec 11, T40S, R47E/ 43 SJ, 9 May 1981/ mostly "sand pine" scrub, burned in 1971, now 2 m oaks, scattered 2-3 m sand pines.

2. JONATHAN DICKINSON STATE PARK, vicinity of entrance station and scout camp/ NE 1/4 Sec 2, T40S, R42E/ 27 SJ, 9-10 May 1981/ "sand pine" scrub, burned in 1971, now 2 m oaks, 2-3 m sand pines.

3. JONATHAN DICKINSON STATE PARK, on main park road, 0.7-1.3 mis W FEC RR tracks/ E 1/2 Sec 10 and/or W 1/2 Sec 11, T40S, R42E/ 6 SJ, 9 May 1981/ scattered "islands" of scrub (1-2 m oaks, 4-5 m sand pines), surrounded by open slash pine flatwoods.

4. JONATHAN DICKINSON STATE PARK, along paved road, from main park road to Pine Grove Campground/ W 1/2 Sec 12, T40S, R42E/ 9 SJ, 10 May 1981/ sand pine scrub and oak scrub, some portions disturbed.

5. JONATHAN DICKINSON STATE PARK, along FEC RR tracks, from main park road south to Palm Beach Co. line/ E 1/2 Sec 11, SW 1/4 Sec 12, W 1/2 Sec 13, E 1/2 Sec 24, T40S, R42E/ 11 SJ, 10 May 1981/ scattered areas of 2-3 m oak scrub with scattered 10 m slash pines.

6. JONATHAN DICKINSON STATE PARK, on US 1 along east park boundary, about 0.2 mis N of south park boundary/ NE 1/4 Sec 13, T40S, R42E/ 2 SJ, 9 May 1981/ 2 m oak scrub.

7. PORT SALERNO, on Indian Ave, about 1.5 mis E SR A1A, SE of Witham Field ("Port Sewall")/ NE corner Hanson Grant/ 2 SJ, Nov-Dec 1980 (R. E. Roberts, in litt.)/ remnant sand pine scrub between houses.

8. PORT SALERNO, on Cove Rd (C-722), 0.2-0.3 mis E SR A1A/ NW 1/4 Sec 30, T38S, R42E/ 2 SJ, Nov-Dec 1980 (R. E. Roberts (in litt.); 2 SJ, 10 May 1981 (J. A. C.)/ 1-5 m oak scrub.

9. S of PORT SALERNO, about 2.5 mis S Port Salerno, just N of where SR A1A crosses FEC RR tracks ("Fruita")/ SW 1/4 Sec 29, T38S, R42E/ 3 SJ, Nov-Dec 1980 (R. E. Roberts, in litt.); 5 SJ, 10 May 1981 (J. A. C.)/ 1-3 m oak scrub.

10. S of PORT SALERNO, on Miller Rd, 0.0-0.5 mis E SR A1A (about 2 1/2 mis N "Gomez")/ NE part of Gomez Grant/ 6 SJ, 10 May 1981/ 2-3 m oak scrub, scattered slash pines.

11. STUART, on St. Lucie Blvd, N of SR A1A, by Cedar Pointe Apts/ center Sec 2, T38S, R41E/ 4 SJ, Nov-Dec 1980 (R. E. Roberts, in litt.); 5 SJ, 10 May 1981 (J. A. C.)/ disturbed oak scrub, being developed.

Ocala National Forest (parts of Lake, Marion, and Putnam Counties)

Note -- In the list of sites in Ocala National Forest, "age" is the year in which the stand was reseeded with sand pines following clearing.

1. W side FR 97, 0.15-0.45 mis S FR 77/ SE 1/4 Sec 26, T11S, R24E/ 2 SJ, 22 Feb 1981; 3 SJ, 24 Oct 1981; estimated 14.3 SJ/40 ha, 1982 census; 10 ad, 6 juv SJ, 17 Aug 1983/ 1-2 m scrub oaks, few sand pines; age = 1978; study site F78P.

2. E side FR 97, 0.75-1.1 mis N FR 31/ SW 1/4 Sec 36, T11S, R24E; NW 1/4 Sec 1, T12S, R24E/ 3 SJ, 14 Apr 1981; 3 SJ, 24 Oct 1981/ 2-4 m scrub oaks, 6-8 m sand pines; age = 999 (reseeded at least twice).

3. S end of Rodman Dam/ S 1/2 Sec 29, T11S, R25E/ 5 SJ, 5 Apr 1980; 4 SJ, 22 Feb 1981/ sand pine scrub, some areas without pines, surrounding borrow pit.

4. N side FR 31, 0.0-0.25 mis E FR 97; E side FR 97, 0.0-0.3 mis N FR 31/ SW 1/4 Sec 1, T12S, R24E/ 6-7 SJ, 29 Jan 1981, 22 Feb 1981, and 10 Apr 1981; 1 SJ, 2 May 1982/ 2-4 m scrub oaks, 5-10 m sand pines; age = 999 (reseeded at least twice).

5. N side FR 31, 0.25-0.45 mis E FR 97/ SW 1/4 Sec 1, T12S, R24E/ 5 SJ, 10 Apr 1981; 3-4 SJ, 21 Aug 1982; 6 ad, 3 juv SJ, 29 Aug 1983 (birds also use Ocala 6, directly across road)/ 5-7 m sand pines; age = 1973.

6. S side FR 31, 0.25-0.45 mis E FR 97/ NW 1/4 Sec 12, T12S, R24E/ 2 ad, 1 juv SJ, 17 Jul 1982; 3-4 SJ, 21 Aug 1982; 6 ad, 3 juv SJ, 29 Aug 1983 (birds also use Ocala 5, directly across road)/ 5-7 m sand pines; age = 1971.

7. N side FR 31, 0.45-0.75 mis W FR 97/ S edge Sec 2, T12S, R24E/ 2 SJ, 10 Apr 1981; 2 SJ, 21 Aug 1982; 2 SJ, 29 Aug 1983/ 3 m scrub oaks, scattered 10-15 m sand pines; age = 1965.

8. N and S FR 31, 1.55-1.85 mis E FR 97/ SE 1/4 Sec 6, NE 1/4 Sec 7, T12S, R25E/ 2 SJ, 29 Jan 1981 and 10 Apr 1981; 3-4 SJ, 13 Feb 1982; 3 SJ, 21 Aug 1982; 1 ad, 1 juv SJ, 18 Aug 1983; 7 SJ, 29 Aug 1983/ 2-3 m scrub oaks, 5-6 m sand pines; age = 1971.

9. N side FR 75, 2.05-2.55 mis W FR 97/ S 1/2 Sec 21, T12S, R24E/ 2 SJ, 5 Jun 1981; 2 ad, 2 juv SJ, 21 Aug 1982; 4 ad, 1 juv SJ, 17 Aug 1983/ 2-3 m scrub oaks, 5-6 m sand pines; age = 1975.

10. N side FR 75, 1.85-2.05 mis W FR 97/ SE 1/4 Sec 21, SW 1/4 Sec 22, T12S, R24E/ 2 SJ, 10 Apr 1981/ 2-3 m scrub oaks, 5-6 m sand pines; age = 1971.

11. S side FR 75, 1.95-2.05 mis W FR 97/ SE 1/4 Sec 21, SW 1/4 Sec 22, T12S, R24E/ 2 SJ, 29 Aug 1983/ 2-3 m scrub oaks, few sand pines; age = 1975.

12. S side FR 75, 1.35-1.65 mis W FR 97/ S edge Sec 22, N edge Sec 27, T12S, R24E/ 2 SJ, 29 Jan 1981, 10 Apr 1981, 17 Jul 1982, 21 Aug 1982, and 29 Aug 1983/ 2-3 m scrub oaks, 4-5 m sand pines; age = 1976.

13. W side FR 97, 0.65-0.7 mis N FR 75/ NE 1/4 Sec 23, T12S, R24E/ 2 ad, 3 juv SJ, 18 Aug 1983/ 1-2 m scrub oaks and sand pines; age = 1979 or 1980.

14. S side FR 75, 0.25-0.45 and 0.55-0.75 mis W FR 97/ S 1/2 Sec 23, T12S, R24E/ 7-10 SJ, 29 Jan 1981 and 10 Apr 1981; 3 SJ, 17 Jul 1982; 1 SJ, 21 Aug 1982; 2 ad, 2 juv SJ, 17 Aug 1983; 6 SJ, 29 Aug 1983/ 2 m scrub oaks, 6 m sand pines; age = 1972.

15. N side FR 75, 0.3-0.35 mis E FR 97, and E side FR 97, 0.2-0.25 mis N FR 75/ SW 1/4 Sec 24, T12S, R24E/ 2 SJ, 14 Apr 1981/ 2-3 m scrub oaks, 4-6 m sand pines; age = 1973.

16. N side FR 75, 0.0-0.3 mis E FR 97, and E side FR 97, 0.0-0.2 mis N FR 75/ SW 1/4 Sec 24, T12S, R24E/ 9 SJ, 22 Feb 1981; 4 SJ, 14 Apr 1981; 4 ad SJ, 2 nests, 2 May 1982; 2 ad, 2 juv SJ, 17 Jul 1982; 4 ad, 3 juv SJ, 21 Aug 1982; 5 ad, 5 juv SJ, 17 Aug 1983/ 1-2 m scrub oaks; age = 1979 or 1980.

17. E side FR 97, 0.05-0.15 mis S FR 75/ NW 1/4 Sec 25, T12S, R24E/ 2 SJ, 30 Apr 1982; 1 SJ, 13 May 1982; 3 ad, 1 juv SJ, 21 Aug 1982; 2 SJ, 29 Aug 1983/ 6-8 m sand pines; age = 1973.

18. W side FR 97, 0.6-0.9 mis N C-316/ NE 1/4 Sec 11, T13S, R24E/ 2 SJ, 10 Apr 1981; 3 ad, 3 juv SJ, 29 Aug 1982; 2 ad, 1 juv SJ, 29 Aug 1983/ 2 m scrub oaks, scattered 10 m sand pines; age = 1972.

19. W side FR 97, 1.15-1.4 mis S C-316/ NW 1/4 Sec 24, T13S, R24E/ 2 SJ, 18 Aug 1983/ 1-2 m scrub oaks, 4-6 m sand pines; age = 1974.

20. E and W FR 67, 3.15-3.5 mis S C-316/ NE corner Sec 34, NW 1/4 Sec 35, T13S, R24E/ 6-8 SJ, 30 Apr 1981; 2 SJ, 17 Apr 1982 and 24 Apr 1982; 4 ad, 1 juv SJ, 7 Aug 1982; 4 ad, 2 juv SJ, 18 Aug 1983/ 1-2 m scrub oaks and sand pines; age = 1978.

21. W side FR 67, 4.2-4.25 mis S C-316/ SE 1/4 Sec 35, T13S, R24E/ 4 SJ, 29 Jan 1981/ 2-3 m scrub oaks, 3-4 m sand pines; age = 1975.

22. W side FR 67, 0.65-0.85 mis N C-314/ S 1/2 Sec 1, T14S, R24E/ 3 SJ, 29 Jan 1981; 5 SJ, 29 Aug 1982; 5 ad, 4 juv SJ, 18 Aug 1983/ 2-3 m scrub oaks, 3-5 m sand pines; age = 1975.

23. E side FR 97, 0.2-0.4 mis S C-314/ NE 1/4 Sec 7, T14S, R25E/ 4 SJ, 2 May 1981; estimated 17.9 SJ/40 ha, 1982 census; 3 SJ, 24 Aug 1983/ 6-8 m sand pines; age = 1973; study site F73P.

24. E side FR 97, 0.55-0.75 mis S C-314/ SE 1/4 Sec 7, T14S, R25E/ 3-4 SJ, 27 Mar 1982; 1-2 SJ, 17 Apr 1982; 5 ad, 4 juv SJ, 7 Aug 1982; 3 ad, 3 juv SJ, 24 Aug 1983/ 6-8 m sand pines; age = 1973.

25. E and W of FR 97, 0.35-0.55 mis N FR 86/ SW 1/4 Sec 17, T14S, R25E/ 3 SJ, 7 Nov 1982; 4 SJ, 24 Aug 1983/ 1 m scrub oaks, 1-2 m sand pines; age = 1977.

26. E and W of FR 97, 0.6-0.8 mis N FR 76/ NE 1/4 Sec 32, NW 1/4 Sec 33, T14S, R25E/ 2 SJ, 2 May 1981; 1 SJ, 13 May 1982; 2 ad, 2 juv SJ, 22 Aug 1982; 1 ad, 2 juv SJ, 24 Aug 1983/ 1-2 m scrub oaks, 2-4 m sand pines; age = 1976.

27. E and W of FR 88, 0.2-0.3 mis N FR 86/ SW 1/4 Sec 14, T14S, R25E/ 2 SJ, 4 Apr and 10 Apr 1981; 4 ad, 1 juv SJ, 22 Aug 1982/ 1-2 m scrub oaks, 2-3 m sand pines; age = 1976.

28. E and W of FR 65, 1.7-1.8 mis S FR 86/ SE 1/4 Sec 30, T14S, R26E/ 2 ad, 1 juv SJ, 24 Aug 1983/ 1-2 m scrub oaks, 1-3 m sand pines; age = 1977 (east of road), 1979 (west of road).

29. E side FR 97, 0.9-1.0 mis S FR 76/ SE 1/4 Sec 3, T15S, R25E/ 2 SJ, 7 Nov 1982/ 1-2 m scrub oaks, 1-3 m sand pines; age = 1978.

30. W side FR 97, 2.4-2.55 mis N SR 40/ SW 1/4 Sec 3, T15S, R25E/ 2 SJ and nest, 24 Apr 1982; 3 ad, 1 juv SJ, 4 Aug 1982; 6 ad, 2 juv SJ, 26 Aug 1983/ 1 m scrub oaks; age = 1978.

31. E and W of FR 97, 2.15-2.4 mis N SR 40/ S 1/2 Sec 3, NE 1/4 Sec 10, T15S, R25E/ 4 SJ, 25 Feb 1981; estimated 23.6 SJ/40 ha, 1982 census; 4 ad, 2 juv SJ, 26 Aug 1983/ 2-3 m scrub oaks, scattered sand pines; age = 1971; portion west of FR 97 was cleared in August 1983; study site F71P.

32. E side FR 79, 0.8-1.2 mis S FR 76/ E 1/2 Sec 5, T15S, R25E/ 4 SJ, 25 Feb 1981; 5 SJ, 4 Apr 1981; 2 SJ, 13 Feb and 22 Aug 1982/ 3-4 m scrub oaks, 6-8 m sand pines; age = 1972.

33. Mill Dam Recreation Area, on FR 58 just N of SR 40/ SW 1/4 Sec 17, T15S, R25E/ 2 SJ, 30 Apr 1982 and 29 Aug 1983/ campground surrounded by scrub .

34. E and W of FR 97, 1.2-1.35 mis N SR 40/ NW 1/4 Sec 14, NE 1/4 Sec 15, T15S, R25E/ 3 SJ, 2 May 1981; 3 ad, 1 juv SJ, 4 Aug 1982; 2 SJ, 26 Aug 1983/ 1 m scrub oaks and sand pines; age = 1978.

35. E side FR 65, 1.9-2.1 mis N SR 40/ E 1/2 Sec 7, T15S, R25E/ 2 SJ, 10 Apr 1981; 3 ad, 1 juv SJ, 29 Aug 1983/ 1-2 m scrub oaks, 3-5 m sand pines; age = 1969.

36. E and W of FR 65, 1.8-1.9 mis N SR 40/ SE 1/4 Sec 7, T15S, R26E/ 4 SJ, 10 Apr 1981; 2 ad, 2 juv SJ, 29 Aug 1982/ 2 m scrub oaks, 5 m sand pines; age = 1967.

37. E and W of FR 79, 1.05-1.3 mis S SR 40/ NW 1/4 Sec 28, T15S, R25E/ 2 SJ, 7 Nov 1980; 3 SJ, 2 Nov 1982/ 1-2 m scrub oaks; age = 1978.

38. W side FR 79, 2.2-2.7 mis N FR 95/ W 1/2 Sec 33, T15S, R25E/ 2 SJ, 8 Apr 1981; 2 ad, 1 juv SJ, 22 Aug 1982; 2 SJ, 26 Aug 1983/ 1-2 m scrub oaks, 2-4 m sand pines; age = 1975.

39. E side FR 79, 2.2-2.7 mis N FR 95/ E 1/2 Sec 33, T15S, R25E/ 6 SJ, 7 Nov 1980; 10-16 SJ, 8 Apr 1981; 8 ad, 1 juv SJ, 9 Aug 1982; 2 SJ, 26 Aug 1983/ 1-2 m scrub oaks, 2-4 m sand pines; age = 1976.

40. E side FR 88, 2.75-3.2 mis S SR 40/ SW 1/4 Sec 36, T15S, R25-1/2E; NW 1/4 Sec 6, T16S, R25 1/2E/ 2 SJ, 9 Apr and 30 Apr 1981; 3 SJ, 24 Aug 1982; 2 ad, 4 juv SJ, 26 Aug 1983/ 1-2 m scrub oaks, 4-8 m sand pines; age = 1971.

41. E side FR 79, 0.0-0.8 mis S FR 95, and S side FR 95, 0.0-0.7 mis E FR 79/ NW 1/4 Sec 15, NE 1/4 Sec 16, T16S, R25E/ 6-7 SJ, 19 Mar 1981; 2 SJ, 26 Aug 1983/ 2-3 m scrub oaks, 4-8 m sand pines; age = 1970.

42. S side FR 95, 1.05-1.35 mis E FR 79/ NE 1/4 Sec 15, T16S, R25E/ 2 SJ, 30 Apr 1981; 3 ad, 2 juv SJ, 29 Aug 1982; 2 ad, 2 juv SJ, 26 Aug 1983/ 2-3 m scrub oaks, 4-6 m sand pines; age = 1973.

43. W side FR 79, 0.8-1.1 mis S FR 95/ SW 1/4 Sec 16, NW 1/4 Sec 21, T16S, R25E/ 2 SJ, 5 Jun 1981; 2 ad, 1 juv SJ, 29 Aug 1982/ 6-8 m sand pines; age = 1971.

44. W side FR 79, 1.1-1.3 mis S FR 95; E side FR 79, 1.2-1.3 mis S FR 95/ N 1/2 Sec 21, T16S, R25E/ 3 SJ, 28 Mar 1981; 4 ad, 1 juv SJ, 24 Aug 1982; 6 ad, 3 juv SJ, 23 Aug 1983/ 1-2 m scrub oaks, 2-4 m sand pines; age = 1976.

45. E side FR 79, 1.25-1.3 mis N FR 73/ SE 1/4 Sec 28, T16S, R25E/ 2 SJ, 5 Jun 1981/ 2-3 m scrub oaks, 4-6 m sand pines; age = 1975.

46. E and W of FR 79, 0.3-0.6 mis N FR 73/ SE 1/4 Sec 33, T16S, R25E/ 4 SJ, 7 Nov 1980; 2 ad, 2 juv SJ, 24 Aug 1982/ 2-3 m scrub oaks, 4-6 m sand pines; age = 1975.

47. W side FR 62, 1.25-1.6 mis N FR 95/ S 1/2 Sec 1, N 1/2 Sec 12, T16S, R26E/ 2 SJ, 12 Apr 1981/ 1-2 m scrub oaks, 3-5 m sand pines; age = 1973.

48. E side FR 66, 0.0-0.45 mis S FR 95/ NW 1/4 Sec 22, T16S, R26E/ 2 SJ, 15 Apr and 1 Jun 1981/ 6-8 m sand pines; age = 1971.

49. S side FR 73, 0.2-0.4 mis E FR 88/ SE 1/4 Sec 31, T16S, R26E; NE 1/4 Sec 6, T17S, R26E/ 1 SJ, 30 Apr 1981; 2 SJ, 5 Jun 1981; 2 SJ, 24 Aug 1982; 2 ad, 1 juv SJ, 23 Aug 1983/ 1-2 m scrub oaks, 2-3 m sand pines; age = 1976.

50. S side FR 73, 1.4-1.75 mis E FR 66/ S edge Sec 35, T16S, R26E/ 4 ad, 2 juv SJ, 23 Aug 1983/ 1-2 m scrub oaks, 2-4 m sand pines; age = 1975.

51. N side FR 73, 2.05-2.55 mis E FR 66/ S 1/2 Sec 36, T16S, R26E/ 1 SJ, 15 Apr 1981; 3 ad, 5 juv SJ, 23 Aug 1983/ 2-3 m scrub oaks, 4-6 m sand pines; age = 1973.

52. S side FR 73, 2.2-2.7 mis E FR 66/ S 1/2 Sec 36, T16S, R26E/ 3 SJ, 25 Feb 1981/ 2-3 m scrub oaks, 4-6 m sand pines; age = 1970.

53. E side Lake Co. District Rd 9277, 1.3-1.7 mis N FR 73; W side Lake Co. District Rd 9277, 1.45-1.8 mis N FR 73/ E 1/2 Sec 25, T16S, R26E/ 2 SJ, 7 Nov 1982/ 1-2 m scrub oaks and sand pines; age = 1978.

54. N and S FR 95, 0.0-0.4 mis E Lake Co. District Rd 9277/ NE 1/4 Sec 18, T16S, R27E/ 6 SJ, 7 Nov 1982/ 1-2 m scrub oaks, 1-3 m sand pines; age = 1978.

55. E side FR 66, 0.85-1.3 mis S FR 73/ SW 1/4 Sec 3, NW 1/4 Sec 10, T17S, R26E/ 5 SJ, 1 Nov 1980; 7-9 SJ, 10-12 Apr 1981; estimated 21.8 SJ/40 ha, 1982 census; 7 ad, 2 juv SJ, 23 Aug 1983/ 2 m scrub oaks, 3-4 m sand pines; age = 1975; study site F75P.

56. W side FR 66, 1.25-1.35 mis N FR 87/ SE 1/4 Sec 9, T17S, R26E/ 2 SJ, 10 Apr 1981; 2 SJ, 31 Aug 1982; 2 SJ, 23 Aug 1983/ 2 m scrub oaks, 5-6 m sand pines; age = 1975.

57. E side FR 66, 0.6-0.8 mis N FR 87; W side FR 66, 0.5-0.9 mis N FR 87/ NW 1/4 Sec 15, NE 1/4 Sec 16, T17S, T26E/ 3-4 SJ, 1 Nov 1980; 5 SJ, 10 Apr 1981; 25 SJ, 15-16 Apr 1981; 10 ad, 1 juv SJ, 8 Aug 1982; 4 ad, 1 juv SJ, 23 Aug 1983/ 2-3 m scrub oaks, 6 m sand pines; age = 1975.

58. E side FR 66, 0.15-0.35 mis N FR 87/ SW 1/4 Sec 15, T17S, R26E/ 6 SJ, 10 Apr 1981; 4 SJ, 24 Aug 1982/ 1-3 m scrub oaks, 4-6 m sand pines; age = 1972.

59. W side FR 66, 0.0-0.35 mis N FR 87/ SE 1/4 Sec 16, T17S, R26E/ 1 SJ, 10 Apr 1981/ 3-6 m scrub oaks, 5-10 m sand pines; age = 999 (reseeded at least twice).

60. E side FR 88, 0.8-0.85 mis N FR 87/ NW 1/4 Sec 18, T17S, R26E/ 2 SJ, 7 Nov 1980 and 15 Apr 1981/ 3-4 m scrub oaks, very dense; age = 1925.

61. N side SR 42, about 3 mis W SR 44; "Forest Hills"/ SW 1/4 Sec 16 or SE 1/4 Sec 17, T17S, R29E/ 3 SJ, 1 Apr 1981/ 6 m sand pines.

Okeechobee County

1. BASINGER, N side US 98, 0.65-0.75 mis W C-700A; S side US 98, 0.9-1.1 mis W C-700A/ NW 1/4 Sec 34, T35S, R33E/ 3 SJ, 28 Dec 1982/ palmetto scrub and 2-4 m oak scrub.

Orange County

1. BAY RIDGE, on Ondich Rd, 0.2-0.8 mis W Plymouth-Sorrento Rd/ S 1/2 Sec 1, N 1/2 Sec 12, T20S, R27E/ SJ reported by D. Brigham (in litt.); 4 ad, 2 juv SJ, 14 Aug 1981 (J. A. C.)/ 3-4 m oak scrub, scattered 10-12 m sand pines, some cleared for houses.

2. E of BAY RIDGE, Rock Springs Run State Reserve, northeast of Wekiwa Springs State Park/ SE 1/4 Sec 1, NE 1/4 Sec 12, T20S, R28E; N 1/2 and SW 1/4 Sec 6, NW 1/4 Sec 7, T20S, R29E/ 12 SJ, 31 Mar 1981; 16 ad, 3 juv SJ, 23 Jul 1983/ oak scrub, palmetto scrub, sand pine scrub (continuous with Lake Co. 22).

3. SW of LAKE BUENA VISTA, on Walt Disney World property/ SE 1/4 Sec 34, T24S, R27E/ 4-5 SJ reported by F. W. Harden (in litt.)/ oak scrub.

4. SW of ORLANDO, W side SR 439, 0.55 mis N junction I-4 (across I-4 from Holiday Inn)/ SE 1/4 Sec 26, T23S, R28E/ 2 ad, 2 juv SJ, 13 Aug 1981/ 2-3 m oak scrub, some sand pines; most nearby scrub cleared for developments or citrus groves.

5. SE of ORLANDO, on private property, about 5 mis SE of Orlando/ SE 1/4 Sec 13 or NE 1/4 Sec 24, T23S, R31E/ 10-15 SJ reported by R. Delotelle (pers. comm.)/ oak scrub, some to be cleared beginning in 1983.

6. S of ORLANDO, N side Moss Park Rd, 0.8-1.3 mis E SR 15/ E 1/2 Sec 8, W 1/2 Sec 9, T24S, R31E/ 1 SJ, Dec 1980 (D. Freeman, in litt.)/ oak scrub and scrubby pasture.

7. S of ORLANDO, W side SR 15, 0.4-0.8 mis N Osceola Co. line/ W 1/2 Sec 32, T24S, R31E/ 1 SJ, 12 Aug 1981/ palmetto scrub.

8. WEKIWA SPRINGS STATE PARK, N of Sand Lake, on primitive road going back towards River Cabin Road/ center Sec 23, T20S, R28E/ 1 ad, 2 juv SJ, 14 Aug 1981/ 1-3 m oak scrub, scattered slash pines; burned in 1981.

Osceola County

1. W of YEEHAW JUNCTION, in SW corner of Osceola Co./ N 1/2 Sec 27, T32S, R32E/ SJ seen 1979-1981 (M. Allen, in litt.)/ palmetto-oak scrub.

2. S of YEEHAW JUNCTION, E side US 441, 1.65-2.45 mis S SR 60; W side US 441, 1.65-1.95, 2.45-2.95, and 3.2-3.35 mis S SR 60/ SE 1/4 Sec 23, W 1/2 Sec 25, NE corner Sec 26, T32S, R34E/ 3 SJ, 26 May 1982 (M. Kuntz and H. W. Kale II, in litt.); 1 SJ, 17 Apr 1983 (J. A. C.)/ oak scrub, some burned 1981 or 1982.

Palm Beach County

1. BOYNTON BEACH, between NW 19th Ave and Boynton Pkwy, and between I-95 and Seacrest Blvd/ SW 1/4 Sec 16, T45S, R43E/ 2 SJ, Nov 1980 (J. F. Sandella, in litt.); 2 SJ, 8 May 1981 (J. A. C.)/ disturbed 2-3 m oak scrub.

2. BOYNTON BEACH, Four Sea Suns Apts, between NE 16th Ave and NE 20th Ave, and between NE 2nd Lane and NE 4th St/ SE 1/4 Sec 16, T45S, R43E/ 4 SJ, Nov 1981 (J. F. Sandella, in litt.)/ oak scrub (?).

3. BOYNTON BEACH, between Seacrest Blvd and US 1, N of SE 20th Ave, S of Water Treatment Plant and Sunshine Square Shopping Center/ NE 1/4 Sec 33, T45S, R43E/ 4 SJ, Nov 1980 (J. F. Sandella, in litt.); 1 SJ, 8 May 1981 (J. A. C.)/ disturbed 1-6 m oak scrub.

4. BOYNTON BEACH, between N Swinton Ave, Seacrest Blvd, Bonnieview Rd, and Church Rd/ NW 1/4 Sec 4, T46S, R43E/ 2 SJ, Nov 1980 (J. F. Sandella, in litt.); 1 SJ, 8 May 1981 (J. A. C.)/ disturbed 2-4 m oak scrub, scattered slash pines.

5. BOYNTON BEACH, between Seacrest Blvd and Old Dixie Highway, and between SE 31st Ave and SE 35th Ave/ NW 1/4 Sec 4, T46S, R43E/ 6 SJ, Nov 1980 (J. F. Sandella, in litt.); 3 SJ, 8 May 1981 (J. A. C.)/ disturbed 3-6 m oak scrub.

6. DELRAY BEACH, between SW 20th Ave and SCL RR, and between Lowson Blvd and Linton Blvd/ SE 1/4 Sec 19, T46S, R43E/ 5 SJ, Nov 1980 (J. F. Sandella, in litt.); 3 ad, 3 juv SJ, 8 May 1981 (J. A. C.)/ 2-3 m oak scrub.

7. DELRAY BEACH, along Congress Ave, just S of Old Germantown Rd/ NE 1/4 Sec 30, T46S, R43E/ 3 SJ, Nov 1980 (J. F. Sandella, in litt.)/ 2-4 m oak scrub, apparently to be developed soon.

8. DELRAY BEACH, W side FEC RR, N and S of Hidden Valley Blvd/ E 1/2 Sec 32, T46S, R43E/ 5 SJ, Nov 1980 (J. F. Sandella, in litt.); 4 SJ, 8 May 1981 (J. A. C.)/ 2-3 m oak scrub, some sand pine scrub to north and south; all "For Sale".

9. JUNO BEACH, on Ellison Wilson Rd, between Donald Ross Rd and Juno Rd/ SW 1/4 Sec 28, E 1/2 Sec 29, E edge Sec 32, W edge Sec 33, T41S, R43E/ 2 SJ, Nov 1980 (C. H. Plockelman, in litt.); 2 SJ, 8 May 1981 (J. A. C.)/ 2-3 m oak scrub, scattered sand pines; some areas cleared.

10. JUNO BEACH, Seminole Golf Course/ NE 1/4 Sec 33, T41S, R43E/ several reports of SJs/ golf course with scattered scrub thickets.

11. JUPITER, USAF Missile Data Collection Annex, on SR A1A-707, just E of US 1/ NE 1/4 Sec 31, T40S, R43E/ 1 SJ, 8-9 May 1981/ sand pine scrub, several openings in canopy.

12. JUPITER, N side Indiantown Rd (SR 706), 1.7-1.8 mis W SR A1A Alt, opposite Commerce Way/ NW 1/4 Sec 2, T41S, R42E/ 3 ad, 2 juv SJ, 9 May 1981; 1 SJ, 11 Aug 1982/ disturbed 2-3 m oak scrub, posted "Will Divide".

13. JUPITER, along Indiantown Rd (SR 706), between US 1 and SR A1A; and in angle between SR A1A and DuBois Rd; around Burt Reynolds Dinner Theatre/ E 1/2 Sec 6, T41S, R43E/ 8 SJ, 9 Nov 1980 (C. H. Plockelman, in litt.); 13 ad, 1 juv SJ, 9 May 1981 (J. A. C.); 3 SJ, 11 Aug 1982 (J. A. C.)/ 1-3 m oak scrub, some 4-5 m sand pines; most of the scrub south of Indiantown Rd was cleared between May 1981 and Aug 1982.

14. JUPITER/JUNO BEACH, along US 1, from 0.5 mis S Indiantown Rd (SR 706), S to Donald Ross Rd/ W 1/2 Sec 8, SW 1/4 Sec 16, E 1/2 Sec 17, W 1/2 Sec 21, T41S, R43E/ 4 SJ, Nov-Dec 1980 (C. H. Plockelman, in litt.); 5 SJ, 9 May 1981 (J. A. C.)/ 2-3 m oak scrub, some being developed.

15. TEQUESTA, on Old Dixie Highway, between Martin Co. line and Tequesta Dr/ W 1/2 Sec 30, T40S, R43E/ 1 SJ, 6 Dec 1980 (C. H. Plockelman, in litt.)/ mostly sand pine scrub, some openings in canopy.

Pasco County

1. HUDSON, "Beacon Woods" development, S side Fivay Rd, E of US 19; Beacon Woods Golf Course/ SE 1/4 Sec 34, T24S, R16E; NW 1/4 Sec 2, NE 1/4 Sec 3, T25S, R16E/ SJ reported by K. Forrest (in litt.); 4 juv, SJ, 13 Jun 1981 (J. A. C.)/ remnant oak scrub, being developed.

2. W of SAN ANTONIO, about 2 mis N SR 52 and 2 mis W C-581/ Sec 34, T24S, R19E/ 3 SJ, 26 Jan 1977 (R. Mumme, in litt.)/ oak scrub.

Polk County

1. AVON PARK BOMBING RANGE, on Frostproof Rd, between Bravo Rd and Carter Rd/ SW 1/4 Sec 2, NE 1/4 Sec 11, SW 1/2 Sec 12, NE 1/4 Sec 13, T32S, R29E/ 6 SJ, 1 Aug 1981/ scattered scrubby pastures and oak scrub.

2. AVON PARK BOMBING RANGE, on Old Bravo Rd, 1.1-3.0 mis N Kissimmee Rd/ W 1/2 Sec 25, middle (NW-SE) Sec 36, T32S, R30E/ 14-15 SJ, 1 Aug 1981/ oak scrub, sand pine scrub, second-growth scrub.

3. SW of AVON PARK BOMBING RANGE, on SR 64, 0.0-1.6 mis N Highlands Co. line/ SE 1/4 Sec 34, W 1/2 Sec 35, T32S, R29E/ 5 SJ, 1 Aug 1981/ mostly sand pine scrub, some open areas.

4. FROSTPROOF, W side C-630, 0.0-0.75 mis N C-630A; E side C-630, 0.4-0.75 mis N C-630A/ E edge Sec 36, T31S, R27E; W edge Sec 31, T31S, R28E/ 2 SJ, 11 Sep 1981/ open sand pine scrub and slash pine scrub.

5. E of FROSTPROOF, W side Lake Reedy Blvd, 0.9-1.3 mis N Lake Arbuckle Rd/ SE 1/4 Sec 36, T31S, R28E/ 2 SJ, 30 Aug 1981/ 2 m oak scrub.

6. E of FROSTPROOF, on unpaved, southward extension of Lake Walk-In-The-Water Rd, 0.0-0.95 mis S SR 630/ N 1/2 and SW 1/4 Sec 30, T31S, R29E/ SJ reported by A. F. Johnson (in litt.); 4 SJ, 29-30 Aug 1981 (J. A. C.)/ oak scrub and slash pine scrub.

7. SE of FROSTPROOF, on Lake Arbuckle Rd, 0.3-2.0 mis E Lake Reedy Blvd; and on Ruck's Dairy Rd, 0.0-0.9 mis S Lake Arbuckle Rd/ SE 1/4 Sec 1, T32S, R28E; S edge Secs 5 and 6, N edge and E edge Sec 7, N edge and W 1/2 Sec 8, T32S, R29E/ 13-15 ad, 1 juv SJ, 30 Aug 1981/ mosaic of oak scrub and grassy ponds, with scattered slash pines.

8. FROSTPROOF, W side US 27, 0.85-1.1 mis N US 27A; "Sunray Delimited Area," near corner of Harvard Ave and US 27/ SE corner Sec 13, T32S, R27E/ 3 SJ, 28 Aug 1981/ 2-3 m oak scrub.

9. SE of FROSTPROOF, on Old Avon Park Rd, 1.8-3.9 mis S Wilson Rd/ W edge Secs 14, 23, and 26, E edge Secs 15, 22, and 27, T32S, R28E/ 3 SJ, 30 Aug 1981/ scattered areas of oak scrub.

10. SE of FROSTPROOF, on dirt road 1/2 mi N of Highlands Co. line, 0.35-0.85 mis W Old Avon Park Rd/ middle (E-W) Sec 34, T32S, R28E/ 1 SJ, 30 Aug 1981/ palmetto scrub.

11. E of HAINES CITY, on Marion Creek Rd, 1.4-2.3 mis E C-580/ middle (N-S) Sec 29, T27S, R28E/ SJ reported by C. Geanangel (in litt.) and L. H. Walkinshaw (in litt.); 3 SJ, 12 Sep 1981 (J. A. C.)/ 2-4 m oak scrub, scattered sand and slash pines.

12. INDIAN LAKE ESTATES, intersection SR 630 and DeLand Ave; N side SR 60, 0.25-0.6 mis NW SR 630; on Park Ave, between DeLand Ave and DeSoto Ave; on DeSoto Ave, 0.3 mis S Park Ave; on Allamanda Dr, just W DeSoto Ave/ S 1/2 Sec 4, SE 1/4 Sec 5, SE corner Sec 8, SE 1/4 Sec 9, T31S, R30E/ 2 SJ, Nov 1980 (C. Geanangel, in litt.); 13-14 SJ, 29 Aug 1981 (J. A. C.)/ oak scrub; roads laid out, several houses completed, few new ones under construction.

13. LAKE KISSIMMEE STATE PARK, N and S of entrance station/ SW 1/4 Sec 12, NW 1/4 Sec 13, T29S, R29E/ 3 SJ, 29 Aug 1981/ 2-6 m oak scrub.

14. LAKE KISSIMMEE STATE PARK, "Buster Island"/ N 1/2 Sec 36, T29S, R29E; W 1/2 Sec 30, T29S, R30E/ several reports of 8-12 SJs/ oak scrub.

15. NE of LAKE WALES, N side Camp Mack Rd, 0.35-0.65 mis W Barney Keen Rd (= Boy Scout Camp Rd); "Moneytree Ranchettes"/ S 1/2 Sec 30, T29S, R29E/ SJ reported by L. H. Walkinshaw (in litt.); 3 SJ, Nov 1980 (C. Geanangel, in litt.); 3 SJ, 29 Aug 1981 (J. A. C.)/ 1-2 m oak scrub, being cleared.

16. E of LAKE WALES, on Boy Scout Camp Rd, between SR 60 and Camp Mack Rd/ W edge Secs 29 and 32, E edge Secs 30 and 31, T29S, R29E; W 1/2 Sec 5, E edge Secs 6 and 7, W edge Sec 8, T30S, R29E/ SJ reported by C. Geanangel (in litt.) and L. H. Walkinshaw (in litt.); 8 ad, 2 juv SJ, 29 Aug 1981 (J. A. C.)/ about 70% of habitat on both sides of the road is scrub (oak scrub and sand pine scrub); most of the other habitat has been cleared for pastures or citrus groves.

17. SW of LAKE WALES, on Crews Rd, 1.4-2.7 mis N Alturas-Babson Park Cutoff Rd/ W 1/2 Sec 17, W 1/2 Sec 20, T30S, R27E/ 2 SJ, Nov 1980 (C. Geanangel, in litt.); 3 SJ, 28 Aug 1981 (J. A. C.)/ 3-10 m turkey oak scrub.

18. SW of LAKE WALES, on Lake Buffum Rd, 0.9-1.65 mis S Alturas-Babson Park Cutoff Rd/ SW 1/4 Sec 32, T30S, R27E; NW 1/4 Sec 5, T31S, R27E/ 2 SJ, Nov 1980 (C. Geanangel, in litt.); 3 ad, 1 juv SJ, 28 Aug 1981 (J. A. C.)/ oak scrub, some being cleared.

19. SW of LAKE WALES, on Rhoden-Buffum Rd (= E Buffum Rd), 0.3-0.5 mis S Lake Buffum Rd/ center Sec 5, T31S, R27E/ 1 SJ, 28 Aug 1981/ 2-4 m oak scrub.

20. E of LAKE WALES, E side Lake Walk-In-The-Water Rd, 0.55-1.45 mis S SR 60; W side Lake Walk-In-The-Water Rd, 1.05-1.25 mis S SR 60/ E edge Secs 18 and 19, W edge Secs 17 and 20, T30S, R29E/ SJ reported by C. Geanangel (in litt.), A. F. Johnson (in litt.), and L. H. Walkinshaw (in litt.); 5 ad, 2 juv SJ, 29ug 1981 (J. A. C.)/ oak scrub and sand pine scrub.

21. E of LAKE WALES, E side Lake Walk-In-The-Water Rd, 2.7-3.15 mis S SR 60; W side Lake Walk-In-The-Water Rd, 2.55-3.3 mis S SR 60/ W edge Sec 29, E edge Sec 30, T30S, R29E/ SJ reported by L. H. Walkinshaw (in litt.); 2 SJ, 29 Aug 1981 (J. A. C.)/ disturbed oak scrub, some turkey oaks and longleaf pines; one area being developed.

22. SE of LAKE WALES, on Lake Walk-In-The-Water Rd, 4.3-5.3 mis S SR 60, and west on unpaved road to Tiger Creek Nature Preserve/ N 1/2 Sec 31, W 1/2 Sec 32, T30S, R29E/ SJ reported by C. Geanangel (in litt.) and L. H. Walkinshaw (in litt.); 2 SJ, 29 Aug 1981 (J. A. C.)/ scattered areas of oak scrub and sand pine scrub.

23. SE of LAKE WALES, on Pfundstein Rd, E of Murray Rd and extending into Tiger Creek Nature Preserve/ S edge Sec 2, N edge Sec 11, T31S, R28E/ 2 SJ, Nov 1980 (C. Geanangel, in litt.)/ oak scrub.

24. SE of LAKE WALES, on Lake Walk-In-The-Water Rd, 3.2-4.1 mis N SR 630/ SW 1/4 Sec 5, SE corner Sec 6, E edge Sec 7, W 1/2 Sec 8, T31S, R29E/ 3 SJ, Nov 1980 (C. Geanangel, in litt.); 2 SJ, 29 Aug 1981 (J. A. C.)/ oak scrub and sand pine scrub, small portions cleared.

25. SE of LAKE WALES, on Lake Walk-In-The-Water Rd, 1.6-2.2 mis N SR 630/ SW 1/4 Sec 17, NW 1/4 Sec 20, T31S, R29E/ 2 SJ, Nov 1980 (C. Geanangel, in litt.); 2 SJ, 29 Aug 1981 (J. A. C.)/ oak scrub.

Putnam County (excluding portions in Ocala National Forest)

1. NE of FLORAHOME, on Holloway Rd (2.4 mis E of Florahome), 1.9 mis N SR 100/ SW 1/4 Sec 31, T8S, R25E/ 2 SJ, 2 Feb 1981; 1 SJ, 3 Jul 1983/ oak scrub and sand pine scrub; roads laid out, a few houses.

2. GRANDIN, on C-315, 0.6-0.7 mis N SR 100/ SE 1/4 Sec 5, T9S, R24E/ SJ seen May 1983 (M. Mullis, pers. comm.); 3 SJ, 3 Jul 1983 (J. A. C.)/ 2-6 m oak scrub.

3. PUTNAM HALL, S side SR 26, 0.3 mis W SR 100/ SE 1/4 Sec 2, T9S, R23E/ several reports of Scrub Jays; 2 SJ, 3 Jul 1983 (J. A. C.)/ 2 m oak scrub.

St. Lucie County

1. FORT PIERCE, on Industrial 31st St, N of St. Lucie Blvd, E of St. Lucie County Airport/ center Sec 29, T34S, R40E/ 3 SJ, 3 Dec 1980 (W. and H. Dowling, in litt.); 3 SJ, 11 May 1981 (J. A. C.)/ disturbed scrub, being cleared for industrial park.

2. FORT PIERCE, S side St. Lucie Blvd, directly S of St. Lucie County Airport/ NE 1/4 Sec 31, NW 1/4 Sec 32, T34S, R40E/ 7-9 SJ, 22 Nov 1980 (W. and H. Dowling, in litt.); 2 SJ, 11 May 1981 (J. A. C.)/ disturbed scrub, to be developed.

3. FORT PIERCE, along dirt road on north side of Canal C-25, from 0.5-1.0 mis W N 25th St/ SW 1/4 Sec 33, T34S, R40E/ 2 SJ, 11 May 1981/ remnant oak scrub between houses.

4. FORT PIERCE, along FEC RR tracks, N and S of Savanna Rd/ NW 1/4 Sec 23, SE 1/4 Sec 26, T35S, R40E/ SJ present Nov-Dec 1980 (W. and H. Dowling, in litt.)/ oak scrub and sand pine scrub.

5. S of FORT PIERCE, along FEC RR tracks from C-712 to Walton Rd; including some portions of The Savannahs State Preserve/ E 1/2 Sec 1, NE 1/4 Sec 12, T36S, R40E; SW 1/4 Sec 7, W 1/2 Sec 18, E 1/2 Sec 19, W 1/2 Sec 29, NE corner Sec 30, N 1/2 Sec 32, T36S, R41E/ 11 SJ, Nov 1980 (R. E. Roberts, in litt.); 10 SJ, 11 May 1981 (J. A. C.)/ mostly sand pine scrub, some areas withouh pines.

Sarasota County

1. NW of ENGLEWOOD, on Bayshore Dr and Neptune Dr, S of Overbrook Rd/ NW 1/4 and center Sec 15, T40S, R19E/ SJ reported by S. D. Stedman (in litt.); 6 SJ, 6 Sep 1981 (J. A. C.)/ oak scrub and slash pine scrub, some portions cleared for houses.

2. NW of ENGLEWOOD, on Overbrook RD, 0.5 mis W SR 775/ NE corner Sec 15, T40S, R19E/ 4 ad, 1 juv SJ, 6 Sep 1981/ residential area, no scrub in sight.

3. NW of ENGLEWOOD, on Bayshore Dr, 0.6-1.4 mis W Old Englewood Rd (C-775A)/ NE 1/4 Sec 22, NW 1/4 Sec 23, T40S, R19E/ 3 SJ, 6 Sep 1981/ scrub with scattered houses.

4. OSCAR SCHERER STATE PARK, youth campground/ NW 1/4 Sec 13, T38S, R18E/ 2 SJ, 4 Sep 1981/ edge between slash pine flatwoods and 2-3 m oak scrub.

5. SE of OSPREY, along Seaboard Coast Line Railway tracks, 0.0-0.5 mis N Oscar Scherer State Park/ SW 1/4 Sec 12, NW 1/4 Sec 13, T38S, R18E/ 5 SJ, 4 Sep 1981/ 2-3 m oak scrub.

6. SARASOTA, Philippi Shores Elementary School, corner US 41 (S. Tamiami Trail) and Proctor Rd/ SW 1/4 Sec 5, T37S, R18E/ SJ reported by M. DeRonde (in litt.); 1 SJ, 5 Sep 1981 (J. A. C.)/ school in residential area, no scrub nearby.

7. VENICE, N side Laurel Rd, 0.0-0.5 mis W US 41, and on Shore Rd, 0.0-1.0 mis S Laurel Rd/ SW 1/4 Sec 25, W 1/2 Sec 36, T38S, R18E/ SJ reported by S. D. Stedman (in litt.); 3 SJ, 4 Sep 1981 (J. A. C.)/ 2-4 m oak scrub with many dead snags N of Laurel Rd; scattered scrub patches between houses S of Laurel Rd.

8. VENICE, on Pine Brook Rd, 0.0-1.0 mis N Venice Ave/ SW 1/4 Sec 4, SE 1/4 Sec 5, NE 1/4 Sec 8, NW 1/4 Sec 9, T39S, R19E/ SJ reported by S. D. Stedman (in litt.); 2 SJ, 6 Sep 1981 (J. A. C.)/ scattered areas of palmetto scrub and slash pine scrub; many houses in area.

9. VENICE, N side Venice Farms Rd (= Venice Ave), about 1/2 mi E Pine Brook Rd/ center Sec 9, T39S, R19E/ 3 SJ, 6 Sep 1981/ saw palmetto, wax myrtle, slash pines.

10. VENICE, W of Harbor Dr, between Villas Dr and Beach Rd, and west to Gulf of Mexico/ SE 1/4 Sec 13, T39S, R18E/ SJ reported by S. D. Stedman (in litt.); 2 ad, 1 juv SJ, 4 Sep 1981 (J. A. C.)/ remnant scrub near houses.

11. VENICE, between Green Circle, Golf Drive, and Intracoastal Waterway/ SW 1/4 Sec 17, SE 1/4 Sec 18, T39S, R19E/ SJ reported by S. D. Stedman (in litt.)/ open slash pine scrub, some cleared.

12. VENICE, area bounded by Shamrock Dr, Baffin Rd, and Siesta Dr/ S 1/2 Sec 29, N 1/2 Sec 32, T39S, R19E/ SJ reported by S. D. Stedman (in litt.); 4-6 SJ, 6 Sep 1981 (J. A. C.)/ open slash pine scrub, roads laid out, lots of houses.

13. S of VENICE, E side SR 775, 1.0-1.5 mis S US 41/ W edge Sec 3, T40S, R19E/ SJ reported by S. D. Stedman (in litt.).

14. S of VENICE, on Alamander Ave, 0.5 mis S Belvidere Rd/ center Sec 9, T40S, R19E/ 2 SJ, 6 Sep 1981/ 2-3 m oak scrub, some being cleared for houses.

Seminole County

1. ALTAMONTE SPRINGS, N side Sand Lake Rd, between Wekiva Cove Rd and County Line Rd/ NW 1/4 Sec 7, T21S, R29E/ 2 SJ, 2 Jan 1983 (G. Bretz and H. W. Kale II, pers. comm.); 2 SJ, 23 Jul 1983 (J. A. C.)/ disturbed oak scrub.

2. S of OVIEDO, E side SR 520, 0.3 mis N Orange Co. line; "Palm Valley" mobile home court/ SW 1/4 Sec 34, T21S, R31E/ 4 SJ, 13 Aug 1981/ 1-3 m oak scrub, scattered 10 m slash pines; being developed.

Sumter County

1. NE of CENTER HILL, on SR 48, 0.4 mis W Lake Co line/ NE 1/4 Sec 12, T21S, R23E/ SJ reported by B. Burton (in litt.) and D. K. Voigts (pers. comm.); 2 SJ, 14 Jun 1981 (J. A. C.)/ clumps of scrub oaks in pastures and along road (continuous with Lake Co. 23).

2. S of CENTER HILL, on SR 469, 0.35 mis N Tuscanooga Rd/ SW 1/4 Sec 25, T21S, R23E/ 2 SJ, 14 Jun 1981; 2 SJ, 20 Mar 1983/ pasture, scrub oaks along fences.

3. S of CENTER HILL, on SR 469, 0.35 mis N SR 50/ SE 1/4 Sec 12, T22S, R23E/ 2 SJ, 14 Jun 1981; 3 SJ, 20 Mar 1983/ 1-2 m planted slash pines, sand-live oaks along fence.

4. NW of WILDWOOD, W side I-75, 1.15 mis N C-462/ SE 1/4 Sec 21, T18S, R22E/ 1 SJ, several occasions, 1980-83/ clump of saw palmettoes on right-of-way.

5. W of WILDWOOD, on SR 44, 3.3 mis W I-75/ N 1/2 Sec 6, T19S, R22E/ 3-4 SJ, 21 Feb 1981; 4 SJ, 20 Apr 1981/ grassy palmetto scrub.

Volusia County

1. DE BARY, E side US 17-92, 0.95 mis S Enterprise Rd (just S of Orange City Fire Tower, opposite "Highland Country Estates")/ SE 1/4 Sec 22, T18S, R30E/ 4 ad, 3 juv SJ, 15 Aug 1981/ sand pine scrub.

2. DE BARY, on Benson Junction Road, 0.35 mis W US 17-92/ center Sec 4, T19S, R30E/ 2 SJ, 15 Aug 1981/ disturbed oak scrub.

3. DELAND, SE corner Lake Woodruff National Wildlife Refuge, along SCL RR tracks, about one mi N Highland Park Ave/ Tract 44, unnamed land grant/ 4 SJ, 20 Aug 1981/ open slash pine scrub.

4. DELAND, W side DeLand Municipal Airport, on Molly Ave, 0.4 mis E junction US 17 and SR 11/ NE 1/4 Sec 33, T16S, R33E/ SJ reported by R. W. Loftin (in litt.); 2 ad, 1 juv SJ, 20 Aug 1981 (J. A. C.)/ 2-3 m oak scrub.

5. DELTONA, vicinity Beaver Dr and Barrow St, and Keene Lane and Ivydale Dr/ NW 1/4 Sec 9, T18S, R31E/ 5 SJ, 16 Aug 1981/ 3 m oak scrub, surrounded by mature sand pine scrub; extensive road network, some houses.

6. DELTONA, along Fort Smith Blvd, between Lightfoot St and Preston Ave/ middle (NW-SE) Sec 34, T18S, R31E/ 8 ad, 5 juv SJ, 16 Aug 1981/ 3-4 m scrub oaks, 6-8 m sand pines; probably sand pine scrub burned in early 1970's; extensive road network, scattered houses.

7. EDGEWATER, W side US 1, 2.1-2.9 mis S C-442; E side US 1, 2.55-2.8 mis S C-442/ W 1/2 Sec 12, T18S, R34E/ 2 ad, 2 juv SJ, 21 Aug 1981/ 1-2 m oak scrub, scattered dead snags, burned in 1970's.

8. S of EDGEWATER, on US 1, 3.55 mis S C-442/ SE 1/4 Sec 13, T18S, R34E/ 10 SJ, 21 Aug 1981/ 2-5 m oak scrub east of highway, open slash pine scrub west of highway.

9. HARBOR OAKS, intersection Nova Rd (SR 5A) and Moss Ave/ SE 1/4 Sec 15, T16S, R33E/ 2 SJ, 17 May 1981/ open slash pine scrub, some has been developed.

10. LAKE HELEN, on Main St, 0.0-0.3 mis W I-4/ S edge Sec 25, N edge Sec 36, T17S, R30E/ 1-2 SJ, 21 Aug 1981/ scrubby pasture, one area of good 1-3 m oak scrub.

11. NEW SMYRNA BEACH, intersection Nordman and Willard Streets, N of Airport/ SE 1/4 Sec 35, T16S, R33E/ SJ reported by H. J. Nett (in litt.); 2 SJ, 17 May 1981 (J. A. C.)/ disturbed slash pines scrub, development to south.

12. W of OAK HILL, on Beacon Light Rd, from 1.6 mis north of W Halifax Ave to 0.35 mis S Volco Rd/ E edge Charles Sibbold Grant; E edge Joseph Wales Grant/ 2 SJ, 21 Aug 1981/ fairly narrow N-S strip on 2-4 m oak scrub interspersed with fresh-water marsh; some scrub cleared for citrus groves.

13. W of ORANGE CITY, on Cypress Ave, 1.0-1.2 mis S Blue Springs Ave/ S 1/2 Sec 9, T18S, R30E/ 2 SJ, 15 Aug 1981/ dense 2-3 m oak scrub, scattered 5-8 m sand pines, surrounded by mature sand pine scrub.

14. N of ORMOND BEACH, on SR A1A, 0.0-0.7 mis S Flagler Co. line/ middle (N-S) Sec 32, T12S, R32E/ 1 SJ, 19 Sep 1981/ coastal scrub, some burned 1981.

15. ORMOND BY THE SEA, Ormond By The Sea Recreation Area, W side SR A1A, 3.55-3.7 mis N SR 40/ center Sec 34 (?), T13S, R32E/ SJ reported by H. J. Nett (in litt.); 1 SJ, 19 Sep 1981 (J. A. C.)/ 4-10 m coastal scrub.

16. OSTEEN, on Lemon Bluff Rd, 0.15-0.5 mis E SR 415/ S edge Sec 13, N edge Sec 24, T19S, R31E/ 2 SJ, 15 Aug 1981/ open slash pine scrub.

17. OSTEEN, on Lemon Bluff Rd, 1.4-1.7 mis E SR 415/ S edge Sec 18, N edge Sec 19, T19S, R31E/ 2 SJ, 15 Aug 1981/ 4-6 m oak scrub.

BIOGRAPHICAL SKETCH

Jeffrey A. Cox was born on 14 November 1954 in Paola, Kansas. He grew up in Wichita, Kansas, and graduated from Wichita Southeast High School in 1972. He then attended the University of Kansas, from which he received a B.S. degree in biology in 1976 and an M.A. in systematics and ecology in 1978. He married Cristy Ann Creitz in 1977.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

John William Hardy, Chairman
Professor of Zoology

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Martha L. Crump
Associate Professor of Zoology

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Carmine A. Lanciani
Professor of Zoology

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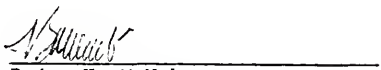
James E. Lloyd
Professor of Entomology and Nematology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.



Brian K. McNab
Professor of Zoology

This dissertation was submitted to the Graduate Faculty of the Department of Zoology in the College of Liberal Arts and Sciences and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August, 1984

Dean for Graduate Studies
and Research